The Bakhshālī Manuscript

An ancient Indian mathematical treatise

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Preface

While I was learning Sanskrit under the late Professor Yutaka Ojihara in the Department of Sanskrit Language and Literature of Kyoto University, I began to study the history of Indian mathematics and astronomy under Professor Michio Yano, and soon I was attracted by a Sanskrit mathematical work called the Bakhshālī Manuscript.

The work had already been studied by eminent Indologists and historians of mathematics such as A. F. R. Hoernle, G. R. Kaye, and B. Datta, to the works of whom we owe much of our knowledge about the manuscript. In fact, it is through their works that I realized its importance in the history of mathematics. Yet a number of mathematical rules and examples in it seemed to me to have been either left undeciphered or misunderstood due mainly to irregularities of the language.

When I went to study in the Department of History of Mathematics of Brown University, Providence, I brought with me my own copy of Kaye's edition, which was accompanied by facsimiles of the manuscript, with the hope of challenging it some day. After some training in reading Sanskrit and Greek mathematical manuscripts, I had an opportunity to read closely the facsimiles under the guidance of Professor David Pingree. My study of the manuscript was conducted from the view points not only of the history of Indian mathematics but also of palaeography, linguistics, meter, weights and measures, and so on. Particularly, the study of linguistic peculiarities of the Bakhshālī Manuscript gave me a basis for my new interpretations of the mathematical rules and examples.

Those researches resulted in my Ph.D. dissertation entitled 'The Bakhshālī Manuscript,' which was submitted to and accepted by the Brown University in 1985. The dissertation consisted of four parts and eight appendices. In Part I (Introduction), in addition to the topics mentioned above, the size and order of the leaves, the special terminology, and so forth, which has already been treated by earlier scholars, are reconsidered more thoroughly. Part II (Sanskrit Text) offers a fresh transliteration of the manuscript based on the facsimiles published by Kaye. The original, birch-bark manuscript is now preserved in the Bodleian Library, Oxford, but I decided to use Kaye's facsimiles because, judging from the tentative transcription of a few leaves newly made by Professor Pingree in 1981, deterioration of the manuscript after Kaye's time seemed undeniable (and unavoidable) due to the fragile nature of birch-bark. Part III (Translation) is the first English translation of the whole text based on the systematic study of the linguistic peculiarities. Part IV (Commentary) is a mathematical commentary based on a comparative study of the Bakhshālī work and other Sanskrit mathematical texts, including a few that were discovered after the publications of earlier studies by my predecessors.

After the submission of the dissertation, I have been trying to improve Part I (Introduction), and actually made some additions and corrections especially in the chapters on the linguistic peculiarities and on the meter. In Part II (Sanskrit Text) I changed the format by separating the text portion from the other information such as the line-numbers, leaf-fragment numbers, etc. I have also added the following as appendices: a list of Sūtras, a concordance of rules and examples, a glossary-index of Sanskrit words (instead of the simple index of the original dissertation), and a list of abbreviations. On the other hand, I have removed an appendix, namely, 'A Note on the Author of the *Gaṇitapañcaviṃśī*,' which is to be published separately. The present book also contains reproduction of the facsimiles originally published by Kaye.

I am deeply grateful to Mr. Gerald J. Toomer (the former Professor of Brown University) and Professor Jan P. Hogendijk (University of Utrecht), who, as official readers of my dissertation at Brown, gave me valuable comments and suggestions in many respects, and to Professor Junko

Sakamoto-Goto (Osaka University), whose detailed comments about the linguistic problems helped me much to improve my linguistic analyses.

I wish to express my many thanks to Doctor Hans T. Bakker and other members of the editorial board of the Groningen Oriental Studies, who accepted my dissertation for publication in the Series, who kindly gave me recommendations with respect to the internal organization of my book, and whose technical assistance helped me to digitalize it. The new format of Part II (Sanskrit Text) of this book is entirely due to them. Thanks are also due to Roelf Barkhuis of the Institute for Indian Studies, Groningen, who carefully worked for reprocessing my original LaTeX files. I also express my sincere gratitude to the publisher, Mr. Egbert Forsten, who has made arrangements for reproducing the facsimiles, and to the Oxford University Press, who prepared the original photographs.

Last but not least, my hearty thanks are also due to Professor David Pingree (Brown University), Doctor Robert E. Goodwin, Professor Michio Yano (Kyoto Sangyo University), Professor Sreeramula Rajeswara Sarma (Aligarh Muslim University), Professor Radha Charan Gupta (Birla Institute of Technology), Professor Takanori Kusuba (Osaka University of Economics), Doctor Karine Chemla and Doctor Kathrine Jami (CNRS), Professor Toshifumi Goto (Osaka University), Professor Thomas Crump (University of Amsterdam), Professor Hideaki Nakatani (Kobe Gakuin University), and Doctor Dominik Wujastyk (Wellcome Institute for the History of Medicine), who encouraged me in various ways to publish my dissertation.

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Saga, Kyoto
July 1994

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My thanks are also due to the following institutions: the Japan Society for the Promotion of Science, whose Junior Fellowship supported me for the first two years of my study at the Brown University; the Brown University, whose scholarship enabled me to continue my study at Brown for the third year; the American Institute of Indian Studies, whose Junior Fellowship (funded by the National Science Foundation of the U.S.A.) enabled me to pursue my study and research of Sanskrit mathematical manuscripts in India in the year beginning from October 1982. This research has brought me, among other things, a xerox copy of the Patan manuscript, an edition of which is included in this dissertation as an appendix. I thank the Shree Hemachandracharya Jain Jnan Mandir, Patan (North Gujarat), for permitting me to publish that manuscript.

February 1985

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PART I

Introduction

CHAPTER 1

Description and Historiography

1.1 Description

- *Location*: Bodleian Library, Oxford, Sanskrit ms., d. 14.
- *Title*: Unknown.
- *Subject*: Mathematics.
- *Author*: Unknown, but 'the son of Chajaka' is probably the commentator, or at least one of the commentators. See Chap. 7 below.
- *Date of the work*: Unknown, but most probably assignable to the seventh century. See Chap. 14.
- *Language*: A corrupt form of Sanskrit. See Chap. 4.
- *Script*: Early Śāradā. See Chap. 3.
- *Size (estimated)*: 16 ± 0.9 cm long and 13.5 ± 0.5 cm wide. See Chap. 2.
- *Number of lines of writing on a page (estimated)*: 11 on an average. See Chap. 2.
- *Number of akṣaras in a line*: Varies from about 20 to 30, the average being 27 or 28.
- *Number of folios*: 70, fol. 19 being entirely blank.
- *Extent*: Incomplete.
- *Materials*: *Bhūrjapatra* or birch-bark. Pen with a flat, rectangular tip.
- *Date of the manuscript*: unknown, but palaeographically assignable to some time between the eighth and the twelfth centuries. See Chap. 3.

1.2 Historiography

Just like the study of the history of Indian mathematics itself, that of the Bakhshālī manuscript has been suffering from two kinds of preocupation, namely, Indian nationalism and Hellenism.

The so-called Bakhshālī manuscript (abbreviated BM) was unearthed by a peasant in 1881 at the village of Bakhshālī, about eighty kilometers (or fifty miles) north-east of Peshawar (Skt. Puruṣapura), one of the important trading centers of the ancient Gandhāra district. As soon as

its discovery was reported in the circle of European orientalists, it aroused the interest of eminent scholars such as G. Bühler and A. Weber because of its age.[1]

The manuscript was first studied by A. F. R. Hoernle, a noted Indologist, who, in 1888, published a short account about it with a transliteration and a translation of several leaves. Lithographs of two leaves (fols. 14^r, 14^v, and 61^v) were also published by him at the same time. Although his dating (3rd or 4th century) of the work contained in the BM was based on rather unsound grounds, his study itself was rightly oriented on the basis of his profound knowledge of Indian languages. It is, therefore, unfortunate that he could not complete his study and edition of the text. The manuscript was presented by him to the Bodleian Library in 1902; the task was to be taken over by G. R. Kaye.

In 1912 Kaye published an article, the aims of which were to refute the date of the Bakhshālī work assigned by Hoernle and to seek for its indebtedness to Greek mathematics. At this time, Kaye's knowledge about the BM was entirely based on Hoernle's article mentioned above. With regard to the date, he says: 'The whole of the positive evidence so far points to some period after the eleventh century A.D. for the date of the manuscript, and also for the date of the composition of the manuscript'; and concludes: 'the manuscript was not written much before the twelfth century A.D.'[2]

Kaye's own study of the BM was published in 1927, fifteen years after the publication of his first article on the BM, together with a transliteration and facsimiles of the whole text. In this study also, his efforts were devoted mainly to the same two aims as were pursued in his previous article, and scarcely to the proper understanding of the BM itself. His strong faith that the Bakhshālī work was written in about the twelfth century under direct foreign influence seems to have clouded his judgement. We, however, owe to Kaye most of our present knowledge about the BM: almost all of his successors, including his chief opponent, B. Datta, have based their arguments on Kaye's study and transliteration of the manuscript. Kaye had intended to publish a revised text as well as his study of the language and meter of the BM, but could not do so due to his death; only his rearranged text with elaborate (but often misleading) notes was posthumously published in 1933 by K. N. Dikshit with a few emendations.

In 1929, before the publication of Kaye's second volume, B. Datta wrote an article, in which, severely criticizing Kaye's arguments about the date and the alleged 'foreign influence,' he assigned the work contained in the BM to 'the early centuries of the Christian era.'[3] Although Datta's arguments about the date were not convincing either, he has made contributions to the proper understanding of several rules and examples including the root-approximation formula.[4]

In 1939, A. A. K. Ayyangar published a short account of the BM, which was intended to reexamine and reassess the biased studies of his predecessors. Since the materials he used were almost the same as those used by Datta, his attempt was not very successful, but his mathematical insight and relatively fair mind enabled him to arrive at a reasonable conclusion about the date. He says: 'However late we may wish to place the manuscript, we cannot well go beyond the tenth century. We therefore come near the times of Sridhara, Mahavira, and Chaturveda with whose works the Bakhshali work has many points in common.'[5]

Unfortunately, however, Ayyangar's estimate of the date was not substantiated by evidence; this is probably why it had been ignored by succeeding writers on Indian mathematics such as

1 For more detailed information about the discovery and the reaction, see Kaye 1927/33, 1–2.
2 Kaye 1912, 356 and 361.
3 Datta 1929a, 57.
4 See Sūtra Q2 in Part 4 (Mathematical Commentary).
5 Ayyangar 1939, 15.

B. Mohan, C. N. Srinivasiengar, and A. K. Bag, until it was revived by D. Pingree in 1981.[6] In the same year, R. C. Gupta wrote a short note entitled 'Centenary of the Bakhshālī Manuscript,' in which he emphasized the necessity of reconsidering the arguments of the earlier scholars in the light of new findings.[7] I agree with him, for the two important works, Bhāskara's *bhāṣya* (A.D. 629) on the *Āryabhaṭīya* and Śrīdhara's *Pāṭīgaṇita* (8th century) with an old anonymous *ṭīkā* published by K. S. Shukla in 1976 and 1959 respectively, do not seem to have been utilized systematically in the study of the BM.[8] Indeed, these works have brought us a great deal of information about Indian mathematics of the seventh and the eighth centuries.[9]

It is unfortunate that our predecessors were so much concerned about the date of the Bakhshālī work that they were apt to neglect efforts for the proper understanding of its contents. It is proposed here to offer a fresh transliteration of the BM based on the facsimiles published by G. R. Kaye, the first English translation of the whole text, and a mathematical commentary on the text. It will also be attempted in later chapters of this Introduction to locate the Bakhshālī work properly within the historical development of Indian mathematics.

6 Mohan 1965, 161–165, Srinivasiengar 1967, 29–30, Bag 1979, 14–15, and Pingree 1981, 59.

7 Gupta 1981, 104.

8 The work of Satyaprakash & Jyotishmati, 1979, has not been available to me.

9 Śrīdhara's authorship of the newly discovered *Gaṇitapañcaviṃśī*, as it stands now, seems to me to be doubtful. See Hayashi 1995.

CHAPTER 2

Size and Order of the Leaves

2.1 Size

Out of the extant seventy leaves of the manuscript, thirty-five were, in Kaye's time, 'in comparatively fair condition,' and these varied in size 'from about $5\frac{1}{4}$ by $3\frac{1}{4}$ inches to 6 by $3\frac{3}{4}$ inches.' Hoernle at first estimated the size of the original leaves to be about 7 by $8\frac{1}{4}$ inches, but he corrected this estimate later. His final estimate was 7 by 4 inches. Kaye's estimate, which agrees fairly with Hoernle's, was $6\frac{1}{2}$ to 7 inches (16.5 to 17.8 cm) long by 4 to $4\frac{1}{2}$ inches (10.2 to 11.4 cm) wide.[1]

Kaye is right when he estimates the length of the original leaves according to the observations that 'there are some lines of writing quite complete, though not many,' and that 'these complete lines measure about $5\frac{1}{2}$ to 6 inches in length.'[2] Although he does not specify the leaves, we find such complete lines on 1^r etc. Also, as Kaye points out, the left and right margins are preserved, if not completely, on some leaves: the former on 43^r etc. and the latter on 42^vF^1 etc. The actual measurements of these as observed in the facsimiles published by Kaye are given in Table 2.1.[3]

We know from Table 2.1A that, except on 44^r and 49^r which show rather exceptional values, the length of one complete line of writing is 14.5 ± 0.6 cm. Assuming 0.8 to 1.2 cm for the left margin and 1.3 to 1.5 cm for the right margin, we obtain 16.9 ± 0.9 cm as the original length of the leaves.

With regard to the width of the leaves, on the other hand, Kaye's estimate is not very convincing. He says without specifying the folios: 'In a few cases we have the complete set of lines (generally from 10 to 11 to the page) and in some other cases the amount missing can be roughly estimated.'[4] I must confess that I could not find such a complete set of lines. However, we now have definite evidence to show that the original width of the leaves was a little greater than the estimate of either Hoernle or Kaye.

A quotation from *Mahābhārata* 1.2.15 to 19a starts on 47^v and continues on 47^r. As usual, the top and bottom of the leaf are broken. It is, however, certain that the last legible line (B in Fig. 2.1) of 47^v only contains the first *pāda* or quarter ('*eko ratho gajaś caiko*') of stanza 15, and that the first legible line (F in Fig. 2.1) of 47^r starts with the sixth *akṣara* (syllabic letter) of the first *pāda* of stanza 17 ('*ṇo nāma*'). Hence the number of the missing *akṣaras* including *daṇḍas* (vertical stroke for punctuation) is:

---

1 Kaye 1927/33, 4 and Hoernle 1888, 33.

2 Kaye 1927/33, 4.

3 Kaye 1927/33, 4, fn. 3, says: 'The reproductions are the same size as actual leaves.'

4 Kaye 1927/33, 4.

Table 2.1: Horizontal Measurements on Leaves

A: Lengths of Complete Lines				B: Left Margin		C: Right Margin	
1^r	14.5 cm	15^r	14.4 cm	43^r	1.2 cm	42^vF^1	1.5 cm
10^r	14.2	15^v	15.0	43^v	1.0	60^r	1.3
10^v	14.8	16^v	14.3	49^r	0.8	61^r	1.3
11^r	14.1	17^r	14.4	59^r	0.9		
11^v	13.9	17^v	15.0	60^v	1.2		
12^r	14.2	18^r	14.7	61^v	1.0		
12^v	14.8	18^v	14.7				
13^r	14.5	43^r	14.2				
13^v	14.6	44^r	12.5				
14^r	14.0	49^r	13.3				
14^v	14.9	50^r	13.9				
		50^v	13.9				

$$7 \textit{ pādas} + 5 \textit{ akṣaras} + 4 \textit{ daṇḍas} = 65 \textit{ akṣaras}$$

Now, since the average number of *akṣaras* to the line on 47^v and 47^r are 22 and 24 respectively, the missing lines of writing must be three in number. There are illegible traces of a line (A in Fig. 2.1) above the first legible line of 47^v, and of another line (C) below line B. There are, therefore, three possible cases as to the distribution of the three missing lines:

1. the first line (C) on 47^v and the rest (D and E) on 47^r;
2. the first two lines (C and D) on 47^v and the rest (E) on 47^r; or
3. all the three lines (C, D, and E) on 47^v.

Whichever the actual case might have been, however, we can obtain the width of the writing space by summing up the extant seven-line space on 47^v and the missing space for the four lines, A, C, D, and E. For, unlike the ordinary practice in writing palm-leaf and paper manuscripts, the writing in the BM starts from the same longer side on both the obverse and reverse of a folio; and line A occupies on 47^v the same place as line F does on 47^r.

The extant seven-line space of 47^v measures 7.8 cm in width; the breadth of a one-line space, i.e., the distance between the top edge of a line and that of the next line, on 47^v and 47^r varies from 0.8 to 1.2 cm. Thus, the original width of the writing space, which contained eleven lines, must have been:

$$7.8 + 0.8 \times 4 = 11.0 \text{ cm}$$

at the least, and

$$7.8 + 1.2 \times 4 = 12.6 \text{ cm}$$

at the most.

The above estimate is corroborated by the value obtained from folio 17. The last visible line of 17^r reads:

Folio		47^v	47^r	
		(A)	F	(:ṇo nāma . . .)
		1		
		2		
		3		
		4		
Lines		5		
		6		
	(eko ratho gajaś caiko:) B =	7		
		(C)		
		⟨D⟩		
		⟨E⟩		

Lines 1 to 7 on 47^v are legible.

Figure 2.1: Position of the Lines of Writing on 47^v and 47^r

⟨pratyayas trairā⟩śikena kar⟨t⟩avyā /

The verification should be made by means of the *trairāśika.*

The rest of the line is filled with wavy lines having several loops like this:  . This no doubt signifies that the line is the real last line of 17^r. The verification referred to in the above sentence is carried out in a large enclosure given at the outset of 17^v. The enclosure must have consisted of four rows, each of which contained one *trairāśika,* although only the fourth row and part of the third are extant. It will be natural to assume that, on 17^v as on 17^r, the last visible line is the real last line. The distance between the bottom line of the enclosure and the bottom edge of the last line of writing measures 6.4 cm. The height of the fourth row of the enclosure is 1.2 cm. Therefore, the width of the original writing space is:

$$6.4 + 1.2 \times 4 = 11.2 \text{ cm}.$$

This value agrees well with the estimate obtained above.

My estimate, therefore, of the width of the original writing space is 11.5 ± 0.5 cm. If we assume one centimeter each for the top and the bottom margins, we have 13 to 14 cm as the width of the original leaves. Thus, my estimate of the original size of the leaves is 16.9 ± 0.9 cm long by 13.5 $\pm$ 0.5 cm wide. Fig. 2.2 illustrates the various estimates made by Hoernle, Kaye, and myself.

2.2 Order

When the BM was deposited with Hoernle for examination, the top and bottom of each leaf were lost, no leaf preserved its folio number, and the order of the leaves was 'in great confusion,' but 'after much trouble,' he says, he 'succeeded in arranging in consecutive order a not inconsiderable portion of the leaves containing eighteen *sūtras.*'[5] Generally speaking, however, it is hard to imagine that the order of the leaves of a manuscript is in a state of complete disorder, unless somebody

5 Hoernle 1888, 33.

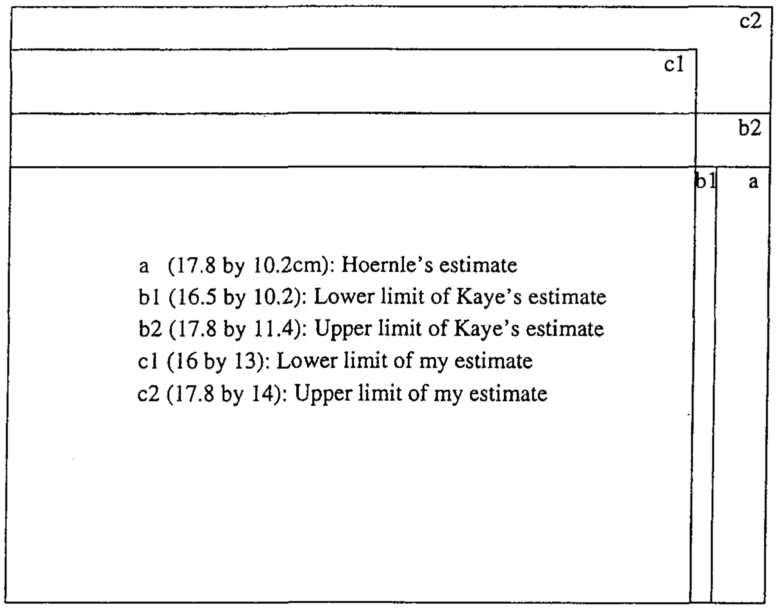


Figure 2.2: Various Estimates of the Size of the Leaves

has intentionally tried to make a mess of the original order. Random errors must have affected the order of the leaves of the BM only to a limited extent. It is unfortunate that Hoernle left only an incomplete record of the 'find order' in which the leaves reached him.[6] The Bodleian Library order of the folios, which I have used as a working hypothesis, is based on Hoernle's arrangement of the leaves.

Kaye improved the situation to some extent by treating the problem systematically.[7] The criteria used by him for his rearrangement are:

1. Logical sequence of contents.
2. The 'find order.'
3. Physical appearance such as the size, shape, degree of damage, and knots.
4. The script and language.
5. Numbered *sūtras*.

In my own arrangement of the leaves, I have used the same criteria, excepting the fourth, i.e., the script and language, which seems to me to be of little use for this purpose.

According to Kaye, the writing of the BM can be classified into two styles, α and β, and style α into four subclasses, $\alpha_1, \alpha_2, \alpha_3$, and α_4.[8] Kaye may be right in differentiating his 'M section' from the rest of the work on the ground that style β 'pertains wholly to the "M" section,' but the apparent differences between the subclasses of α are too meagre to be a criterion for the order.[9] The writing

6 Kaye 1927/33, 12, fn. 1.
7 Kaye 1927/33, 12–14.
8 Kaye 1927/33, 11 and 97.
9 Kaye 1927/33, 11.

on folio 41, for example, has been classified by Kaye as α_4 in one place[10], and as α_1 in another.[11] Even the border line between style α and style β is not always clear to me. The medial 'ai' formed by two top strokes was considered by Kaye as one of the main characteristics of style α. He says that it never occurs in his 'M section.'[12] Actually, however, it does occur in that section, that is, in '*mūkhyair*' on 49^r and '*sāyakaiś*' on 47^v, both of which Kaye himself reads correctly.[13]

The language is still less helpful for resolving the problem of order. All the examples given by Kaye as illustrating differences of language are faulty. He says: '*ghna* "multiplied" occurs only on folios 7, 45, 46, 57, and 65, all of which belong to the same section (C); *pratyaya*, *yuta*, and *rūpa* occur very often but never in "M" section, etc., etc.'[14] In fact, however, the word *ghna* occurs also on 1R, which belongs to his 'A section,' though Kaye failed to read it. The word *yuta* does occur in his 'M section,' that is, on 34^r and 34^v; here he himself reads the word correctly.[15] Further, the word *rūpa* and its abbreviation, *rū*, occur respectively on 42^r and 42^v, both of which belong to his 'M section,' in the sense of a coin. It is true that it does not occur in its other sense, i.e., unity, in the 'M section,' but we cannot attach much importance to this. Not can we find any serious significance in the absence of the term *pratyaya* from the 'M section,' for it is certainly the nature of the problem treated in that section (*trairāśika* or the rule of three) rather than the language that has affected this matter.

The other criteria are useful if, of course, they are used properly.The first criterion, logical sequence of contents, is effective only within a *sūtra* (versified rule) and its applications, for we cannot always expect a logical relationship even between consecutive *sūtras*: a feature that is common in most mathematical texts of medieval times. The third one, physical appearance, is also effective within a small range, while numbered *sūtras* are helpful for the determination of both the order of the leaves within the sections containg them and the relative positions of those sections. The 'find order,' which is known to us incompletely, is useful as a check to some extent; it should be turned to for help only when there is no other means.

By using these criteria, I have obtained ten sections, I to X, as have been shown in Table 2.2. Within each of Sections II, III, IV, VI, VII, VIII, and IX, the order of leaves is almost certain, while in the other sections (I, V, and X) the order given is merely of a compromising character, and so also are the relative positions of these ten sections. The main grounds on which I have based my arrangement of the leaves are given in the next section.

Table 2.3 shows relationships between the 'find order' and the revised order. It will be observed that the 'inverse find order' locally corresponds very well to the revised order. See the 'find order' for Sections III and IV, within each of which the order of leaves has been definitively determined by other means.

I have classified all the *sūtras* of the BM into four categories.

1. Numbered *sūtras*.
2. *Sūtras* whose serial numbers have not been identified (noted as Sūtra N-).
3. *Sūtras* whose existence is conjectured (noted as Sūtra C-).

10 Kaye 1927/33, 214, J3.
11 Kaye 1927/33, 97.
12 Kaye 1927/33, 96.
13 Kaye 1927/33, 213 and 228.
14 Kaye 1927/33, 12.
15 Kaye 1927/33, 226.

4. *Sūtras* which occur only as quotations (noted as Sūtra Q-).

The same notation is employed in Table 2.2 and in Section 2.3 also. It should be remembered that no examples of the BM are numbered in the manuscript itself; I have numbered the extant examples in the apparent order for the sake of easy references.

Table 2.2: Revised and Other Orders

Revised order		Bodleian order	Kaye's order	Find order	Sūtras
I	1, 2	70^{rv}	D 2	65	N1
	3, 4	69^{rv}	D 3	64	
	5, 6	68^{rv}	D 4	64	
	7, 8	67^{vr}	D 6	62	C1, N2
	9, 10	31^{rv}	D 5	63	C2, N3
	11, 12	30^{vr}	J 1 (^{rv})	32	
	13, 14	28^{rv}	D 7	60	
	15, 16	66^{rv}	E 1	58	N4
	17, 18	53^{rv}	E 2	?	N5, C3
II	1	54^{r}	A 4	?	N6
	2, 3	35^{rv}	A 5	?	
	4	54^{v}	A 4	?	
	5, 6	[16] $35\#^{rv}$	A 6	37	
	7, 8	51^{rv}	A 7	37	
	9, 10	52^{rv}	A 8	37	C4
III	1, 2	1^{rv}	A 11	33	9, 10, 11
	3, 4	2^{rv}	A 12	34	
	5, 6	3^{vr}	A 13 (^{rv})	49	13, 14, 15
	7, 8	4^{rv}	B 4	44	16, 17
	9, 10	5^{rv}	C 1	47	18, 19
	11, 12	6^{rv}	C 2	46	
	13, 14	7^{rv}	C 3, B 3	45	20
	15, 16	8^{rv}	B 1	48	21, 22
	17, 18	9^{rv}	B 2 (^{vr})	43	23, 24
	19, 20	10^{rv}	G 1	42	25
	21, 22	11^{rv}	G 2	41	
	23, 24	12^{rv}	G 3	40	
	25, 26	13^{rv}	G 4	39	
	27, 28	14^{rv}	G 5	?	
	29, 30	15^{rv}	G 6	29	26
	31, 32	16^{rv}	G 7, H 1	30	27
	33, 34	17^{rv}	H 2	28	
	35, 36	18^{rv}	H 3	27	28, 29
IV	1, 2	21^{rv}	E 4	55	N7
	3, 4	22^{rv}	E 5, F 1	54	N8, N9

to be continued

16 The symbol # indicates a folio restored from several fragments. $35\#^{r(v)} = 35^{r(v)}F + 51^{r(v)}F^{1}$.

Revised and Other Orders (*continued*)

Revised order	Bodleian order	Kaye's order	Find order	Sūtras
5, 6	23^{rv}	F 2	52	N10
7, 8	24^{rv}	F 3	?	N11, N12
9, 10	25^{vr}	F 4 (^{rv})	51	
11, 12	26^{rv}	F 5	50	C5
V 1, 2	[17]$38\#3^{vr}$	A 3	32	N13
3, 4	[18]$38\#2^{rv}$	A 2	32	C6
5, 6	[19]$38\#1^{rv}$	A 1	32	N14
VI 1, 2	29^{rv}	A 9	32	N15
3, 4	[20]$27\#^{vr}$	A 10 (^{rv})	32	N16, N17
VII 1	65^{v}	C 4	?	N18
2, 3	56^{vr}	C 5	16	
4, 5	64^{rv}	C 6	?	
6, 7	57^{vr}	C 7	?	
8, 9	45^{rv}	C 8	10	
10, 11	46^{rv}	C 9, D 1	9	C7
12, 13	58^{vr}	E 3 (^{rv})	?	C8
VIII 1, 2	59^{vr}	K	?	50, 51
3, 4	60^{rv}	L 1	?	52, 53
5, 6	61^{rv}	L 2	?	54
7, 8	62^{rv}	L 3	55, 56?	
9, 10	63^{rv}	L 4	?	57, 58
IX 1, 2	44^{vr}	M 11	12	C9
3, 4	43^{rv}	M 12	13	
X 1, 2	49^{vr}	M 9	11	C10
3, 4	55^{rv}	M 10	14	
5, 6	20^{rv}	M 1	26	
7, 8	33^{rv}	M 2	25	
9, 10	32^{rv}	M 3	24	
11, 12	36^{rv}	M 4	23	
13, 14	34^{rv}	M 5	22	
15, 16	37^{rv}	M 6	21	
17, 18	41^{vr}	J 3 (^{rv})	?	
19	65^{r}	J 2	?	
20, 21	48^{rv}	M 8	19	
22, 23	47^{vr}	M 7	20	
24, 25	42^{rv}	M 13	18	
26, 27	50^{vr}	M 14	17	N19

17 $38\#3^{r(v)} = 38^{r(v)}F^1 + 39^{r(v)}F^4 + 40^{r(v)}F^3, F^7, F^8$.

18 $38\#2^{r(v)} = 38^{r(v)}F^3 + 39^{r(v)}F^2 + 39^{r(v)}F^7 + 40^{r(v)}F^2, F^6$.

19 $38\#1^{r(v)} = 38^{r(v)}F^2 + 39^{r(v)}F^1, F^3, F^6, F^8 + 40^{r(v)}F^1, F^5$.

20 $27\#^{r(v)} = 27^{r(v)} + 29^{r(v)}F^2$.

Table 2.3: Find Order vs. Revised Order

Inverse find order	Bodleian order	Revised order		
65	70	I	1,	2
64	69		3,	4
64	68		5,	6
63	31		9,	10
62	67		7,	8
61	?			
60	28		13,	14
59	?			
58	66		15,	16
57	?(53?)		(17,	18?)
56	?			
55	21	IV	1,	2
54	22		3,	4
53	?(24?)		(7,	8?)
52	23		5,	6
51	25		9,	10
50	26		11,	12
49	3	III	5,	6
48	8		15,	16
47	5		9,	10
46	6		11,	12
45	7		13,	14
44	4		7,	8
43	9		17,	18
42	10		19,	20
41	11		21,	22
40	12		23,	24
39	13		25,	26
38	?(54?)	II	(1,	4?)
38	?(35?)		(2,	3?)
37	51		7,	8
37	52		9,	10
36	?			
35	?			
34	2	III	3,	4
33	1		1,	2
32	38#	V	1—6	
32	29	VI	1,	2
32	27#		3,	4
32	30	I	11,	12
31	?(14?)	III	(27,	28?)
30	16		31,	32

to be continued

Find Order vs. Revised Order (*continued*)

Inverse find order	Bodleian order	Revised order		
29	15		29,	30
28	17		33,	34
27	18		35,	36
26	20	X	5,	6
25	33		7,	8
24	32		9,	10
23	36		11,	12
22	34		13,	14
21	37		15,	16
20	47		22,	23
19	48		20,	21
18	42		24,	25
17	50		26,	27
16	56	VII	2,	3
15	?(57?)		(6,	7?)
14	55	X	3,	4
13	43	IX	3,	4
12	44		1,	2
11	49	X	1,	2
10	45	VII	8,	9
9	46		10,	11
?	19 (blank)			
?	41	X	17,	18
?	58	VII	12,	13
?	59	VIII	1,	2
?	60		3,	4
?	61		5,	6
?	62		7,	8
?	63		9,	10
?	64	VII	4,	5
?	65		1,	X 19

2.3 Synopsis in the Revised Order

The following is a brief sketch of the contents of the BM in the revised order. The grounds for the rearrangement of leaves are given also.

Section I

The 'find order' and the relatively small sizes of the leaves suggest that these leaves are early leaves.

1	70^r	Ex. 1 for *Sūtra N1*[21] (proportional distribution): '*prakṣepayukti*' is the only extant passage that might have belonged to the *sūtra*. Cf. Sūtra N7 on 21^r (IV 1) below.
		Ex. 2 for Sūtra N1.
2	70^v	Ex. 3 for Sūtra N1.
		Ex. 4 for Sūtra N1.
		Fragment 70^rF^2 is related to Ex. 1 for Sūtra N3 on 31^v–30^v (I 10–11).
3	69^r	Ex. 5 for Sūtra N1.
4	69^v	Ex. 6 for Sūtra N1.
		Ex. 7 for Sūtra N1.
		Ex. 8 for Sūtra N1.
5	68^r	Not understood.
6	68^v	Blank.
		The 'find order' locates fol. 68 between fols. 69 and 31.
7	67^v	Ex. 1 for *Sūtra C1* (rule of inversion).
8	67^r	Continues Ex. 1 for Sūtra C1.
		Sūtra N2 (*huṇḍikā*): '*dinabhaktaviśeṣaṃ ca.*'
		Ex. 1 for Sūtra N2.
9	31^r	Ex. 1 for *Sūtra C2* (*dhanasāmyatā*): mathematically equivalent to Sūtra 53 on 60^v (VIII 4) below.
		Ex. 2 for Sūtra C2.
10	31^v	Ex. 1 for *Sūtra N3* (purchase in proportion): '··· *cchedasaṃguṇe*'(?). Cites Sūtra Q4.
11	30^v	Continues Ex. 1 for Sūtra N3.
12	30^r	Ex. not understood. Cites Sūtra Q8, '*ekayutā narasaṃkhyā*,' which is exactly the same as the first *pāda* of Sūtra 14 on 3^r (III 6).
		The characteristic size and shape connect fol. 30 to fol. 28.
13	28^r	Not understood.
14	28^v	Not understood.
		The 'find order' locates fol. 28 between fols. 67 and 66.
15	66^r	*Sūtra N4* (*samapaṇya*): much mutilated.
		Ex. 1 for Sūtra N4.
16	66^v	Continues Ex. 1 for Sūtra N4.
		Fols. 66 and 53 have the same large knot.
17	53^r	Ex. 1 for *Sūtra N5* (*gatisāmyatā*): '*gatisyaiva viśeṣaṃ tu.*'
		Mathematically equivalent to Sūtra 15 on 3^r (III 6) below.
18	53^v	Ex. 1 for *Sūtra C3* (*samāgama*). Cf. Sūtra 24 on 9^v (III 18) below.

Section II

1	54^r	Ex. 1 for *Sūtra N6*: '*uttarāṃ bhājyato hitvā.*' Cites Sūtra Q10.
		Fol. 54 is a double leaf. See Kaye 1927/33, 162, A4.
		Fragment 54^rF^9 contains '⟨*sap*⟩*tamasūtra.*'
2	35^r	Continues Ex. 1 for Sūtra N6. Cites Sūtra Q10.
		Ex. 2 for Sūtra N6.
3	35^v	Continues Ex. 2 for Sūtra N6.
4	54^v	Ex. 3 for Sūtra N6.

21 A slanted '*Sūtra*-' indicates the first occurence of that *sūtra*.

5	$35\#^r$	Continues Ex. 3 for Sūtra N6.
6	$35\#^v$	Ex. 4 for Sūtra N6.
		Ex. 5 for Sūtra N6 (?) on the under leaf.
7	51^r	Ex. 6 for Sūtra N6.
		Ex. 7 for Sūtra N6.
8	51^v	Ex. 8 for Sūtra N6.
		Fols. 51 and 52 have the same knot.
9	52^r	Ex. 9 for Sūtra N6.
		Ex. 1 for *Sūtra C4* (*bhāgāpavāha* type of problem).
		Directly follows Ex. 9 for Sūtra N6 without a *sūtra*.
10	52^v	Continues Ex. 1 for Sūtra C4.
		One-and-a-half-line space is left blank.

Section III

1	1^r	Ex. 1 for *Sūtra 9* (purport unknown). The solution ends with the phrase, '*hastagataṃ dhanaṃ.*'
		End of Sūtra 9.
		Sūtra 10 (*guṇasāmya*): '*guṇau pṛthagg rūpayutau.*' No example given. Refers to the second leaf.
		End of Sūtra 10.
		Sūtra 11 (*maṇimūlya*): '*aṃśāṃ viśoddhya cchedebhya.*'
		Ex. 1 for Sūtra 11.
2	1^v	Continues Ex. 1 for Sūtra 11.
3	2^r	Continues Ex. 1 for Sūtra 11.
		Ex. 2 for Sūtra 11.
4	2^v	Continues Ex. 2 for Sūtra 11.
		Two-line space is left blank.
5	3^v	Ex. 1 for *Sūtra 13* (*dhanasāmyatā*): '*deyaṃ vaṇikpiṇḍahataṃ.*'
6	3^r	Ex. 2 for Sūtra 13.
		End of Sūtra 13.
		Sūtra 14: '*ekayutā narasaṃkhyā.*' No example given. Refers to a leaf, the serial number of which is missing. Cf. Sūtra Q8 cited on 30^r (I 12) above.
		End of Sūtra 14.
		Sūtra 15 (*gatisāmyatā*): '*gatisyaiva viśeṣaṃ ca.*' Cf. Sūtra N5 on 53^r (I 17) above.
		Ex. 1 for Sūtra 15.
7	4^r	Ex. 2 for Sūtra 15.
		Ex. 3 for Sūtra 15. No solution given. Refers to the eleventh leaf.
		End of Sūtra 15.
		Sūtra 16 (*gatisāmyatā*): '*ādyor viśeṣa kartavyaṃ.*'
		Ex. 1 for Sūtra 16.
8	4^v	Continues Ex. 1 for Sūtra 16. Refers to a leaf, the serial number of which is illegible.
		End of Sūtra 16: '*ṣoḍaśamasūtraṃ* 17,' to which is added the statement, '*sūtre bhrāntim asti*' (There is a corruption in the ⟨numbering of this⟩*sūtra*), by the same hand.
		Sūtra 17 (*gatisāmyatā*): '*ādyor viśeṣa dviguṇaṃ.*'
		Mathematically equivalent to Sūtra 16.

		Ex. 1 for Sūtra 17.
9	5^r	Ex. 1 for *Sūtra 18* (*dhanasāmyatā*). Probably this *sūtra* was either missed or deliberately omitted by the commentator because of its mathematical equivalence to Sūtra 16 and Sūtra 17.
		End of Sūtra 18.
		Sūtra 19 (*gatisāmyatā*): '*dinagamanam ādirahitaṃ.*'
10	5^v	Ex. 1 for Sūtra 19.
11	6^r	Continues Ex. 1 for Sūtra 19.
		Ex. 2 for Sūtra 19.
12	6^v	Continues Ex. 2 for Sūtra 19. Cites Sūtra Q2.
13	7^r	Continues Ex. 2 for Sūtra 19.
14	7^v	Ex. 1 for *Sūtra 20* (*dhanasāmyatā*): '*ādiṃ viśoddhya nityataḥ.*'
		Ex. 2 for Sūtra 20.
15	8^r	Ending mark of, probably, Sūtra 20.
		Sūtra 21 (*karmavṛttisāmyatā*): '*dviguṇaṃ prabhavaṃ śuddhaṃ.*'
		Mathematically equivalent to Sūtra 20.
		Ex. 1 for Sūtra 21.
16	8^v	Ending mark of, probably, Sūtra 21.
		Sūtra 22 (*aśvagantavya*): '*hayair vibhajya gantavyaṃ.*'
		Ex. 1 for Sūtra 22.
17	9^r	*Sūtra 23* (*vipralabdha*): '*labdhaṃ dviguṇaṃ kṛtvā.*'
		Mathematically equivalent to Sūtra 20 and Sūtra 21.
		Ex. 1 for Sūtra 23.
18	9^v	Ex. 1 for *Sūtra 24* (*samāgama*): '*adhvasaṃyogabhaktavyaṃ*' (?). Cf. Sūtra C3 on 53^v (I 18) above.
19	10^r	End of Sūtra 24.
		Sūtra 25 (*dhānta*, = Skt. *dhmāta*): '*kṛtvā rūpakṣayaṃ pārthaṃ.*'
		Ex. 1 for Sūtra 25.
20	10^v	Continues Ex. 1 for Sūtra 25.
		Ex. 2 for Sūtra 25.
21	11^r	Continues Ex. 2 for Sūtra 25.
		Ex. 3 for Sūtra 25.
		Ex. 4 for Sūtra 25.
22	11^v	Continues Ex. 4 for Sūtra 25.
23	12^r	Ex. 5 for Sūtra 25.
24	12^v	Continues Ex. 5 for Sūtra 25.
		Ex. 6 for Sūtra 25.
25	13^r	Continues Ex. 6 for Sūtra 25.
		Ex. 7 for Sūtra 25.
		Ex. 8 for Sūtra 25.
26	13^v	Continues Ex. 8 for Sūtra 25.
		Ex. 9 for Sūtra 25.
27	14^r	Ex. 10 for Sūtra 25.
		Ex. 11 for Sūtra 25.
28	14^v	Ex. 12 for Sūtra 25.
		Ex. 13 for Sūtra 25.
29	15^r	Ex. 14 for Sūtra 25.

		End of Sūtra 25.
		Nearly three-line space is left blank.
30	15^{v}	Ex. 1 for *Sūtra 26 (dhānta)*: '*dhāntaśo ghātitaṃ* ⟨*tataḥ*⟩' is probably the second *pāda* of this *sūtra*.
31	16^{r}	Ex. 2 for Sūtra 26.
		Ex. 3 for Sūtra 26.
32	16^{v}	End of Sūtra 26.
		Sūtra 27 (suvarṇakṣaya): '*kṣayaṃ saṃguṇya kanakāḥ.*'
		Ex. 1 for Sūtra 27.
33	17^{r}	Continues Ex. 1 for Sūtra 27.
		Ex. 2 for Sūtra 27.
34	17^{v}	Continues Ex. 2 for Sūtra 27.
		Ex. 3 for Sūtra 27.
35	18^{r}	*Sūtra 28 (suvarṇakṣaya)*: '*aprāptasaṃguṇā kaṭī.*'
		Ex. 1 for Sūtra 28.
36	18^{v}	End of Sūtra 28.
		Sūtra 29 (suvarṇakṣaya): '*ūnais saṃguṇya kanakā.*'
		Ex. 1 for Sūtra 29.
	19^{r}	Blank.
	19^{v}	Blank.

Section IV

1	21^{r}	Ex. 1 for *Sūtra N7 (prakṣepayukti)*. Cf. Sūtra N1 on 70^{r} (I 1) above.
2	21^{v}	Ex. 2 for Sūtra N7.
3	22^{r}	Continues Ex. 2 for Sūtra N7.
4	22^{v}	Ex. 1 for *Sūtra N8 (iṣṭakarman)*: '*śūnyam ekayutaṃ kṛtvā.*'
		No ending mark for Sūtra N8.
		Sūtra N9 (vargakramagaṇita): '*yadṛcchāṃ vinyase śūnye.*'
5	23^{r}	Ex. 1 for Sūtra N9.
		End of '*vargakramagaṇita*' (arithmetic of multiplicative series). Does not mention the *sūtra* number.
		Sūtra N10 (yutivargagaṇita): '*kāmikaṃ śūnye vinyastaṃ.*'
6	23^{v}	Ex. 1 for Sūtra N10. Ends with the statement, '⟨*e*⟩(*ṣa*) *yutivargagaṇitaṃ*' (This is the arithmetic of additive-multiplicative ⟨series⟩).
		Ex. 2 for Sūtra N10.
7	24^{r}	Ex. 1 for *Sūtra N11*: '*iṣṭāṅkaṃ vinyase śūnye.*' Cites Sūtra Q7.
8	24^{v}	Ex. 1 for *Sūtra N12*: '*śūnyasthāne rūpaṃ.*'
		Ex. 2 for Sūtra N12.
9	25^{v}	Continues Ex. 2 for Sūtra N12.
		Ex. 3 for Sūtra N12.
10	25^{r}	Ex. 4 for Sūtra N12.
11	26^{r}	Ex. 5 for Sūtra N12.
		End of '*tṛprakāra*' (three methods). Cites Sūtra N12 again.
12	26^{v}	Ex. 1 for *Sūtra C5* (proportion in geometry?).

Section V

G. R. Kaye, in his rearrangement of the leaves, has placed this portion at the beginning of the manuscript (A1 to A3), giving three erroneous reasons, that is, the degree of damage, the 'find order,' and the writing (see Kaye 1927/33, 159). In fact, both the 'find order,' 32, and the fact that most fragments of the leaves are preserved in spite of such a large degree of damage indicate that this portion was located in the middle of the book. The writing cannot be a basis for arrangement.

1	38#3^v	Apparently consists of several parts, whose contents can not be related to each other. But Section (^{i}) contains: Ex. 9 for Sūtra N1. See 70^r to 69^v (I 1–4) above.
2	38#3^r	Ex. 1 for *Sūtra N13* (proportional distribution): '*dravyatulyaṃ vinikṣipya.*'
3	38#2^r	Ex. 1 for *Sūtra C6* (proportional distribution).
4	38#2^v	Continues Ex. 1 for Sūtra C6. A large space is left blank at the bottom.
5	38#1^r	*Sūtra N14* (*vāhakāṇḍapramāṇa*): much mutilated. Ex. 1 for Sūtra N14.
6	38#1^v	Continues Ex. 1 for Sūtra N14.

Section VI

1	29^r	*Sūtra N15*: '*icchāṅkaṃ prathame nyasya.*' Ex. 1 for Sūtra N15.
2	29^v	Ex. 2 for Sūtra N15.
3	27#^{v}	Continues Ex. 2 for Sūtra N15.
4	27#^{r}	Ex. 1 for *Sūtra N16* (*bhāvita* type of problem): '*pṛthak rūpaṃ vinikṣipya.*' Ending mark of, probably, Sūtra N16. *Sūtra N17*: '*guṇau* ⟨· · ·⟩*dhanaṃ guṇābhyāso rūpahīnaṃ.*'

Section VII

1	65^v	Ex. 1 for *Sūtra N18* (arithmetical progression): '*aṣṭottaraghne gaṇite.*' Cites Sūtra Q1. Fol. 65 is a double leaf. See Kaye 1927/33, 179, C4.
2	56^v	Continues Ex. 1 for Sūtra N18. The lower part of the page is left blank.
3	56^r	Continues Ex. 1 for Sūtra N18. Cites Sūtra Q2 and Sūtra Q3.
4	64^r	Continues Ex. 1 for Sūtra N18.
5	64^v	Ex. 2 for Sūtra N18. Cites Sūtra Q1 and Sūtra Q2.
6	57^v	Continues Ex. 2 for Sūtra N18. Cites Sūtra Q2.
7	57^r	Continues Ex. 2 for Sūtra N18. Cites Sūtra Q1 and Sūtra Q2 in the solution, and Sūtra Q9 in the verification.
8	45^r	Ex. 3 for Sūtra N18. Ex. 4 for Sūtra N18.
9	45^v	Continues Ex. 4 for Sūtra N18. Cites Sūtra Q1.
10	46^r	Continues Ex. 4 for Sūtra N18.
11	46^v	Ex. 1 for *Sūtra C7* (the so-called Hundred Hens Problem). Ex. 2 for Sūtra C7. Written in a dialect.

The contents connect 46^v and 58^v, and the size and shape connect fol. 46 and fol. 58.

12	58^v	Ex. 3 for Sūtra C7.
13	58^r	Ex. 1 for *Sūtra C8* (purport unknown). Versifies a large number.

Section VIII

1	59^v	Blank.
2	59^r	Ex. 1 for *Sūtra 50*: '*yutahīnaṃ ca m=ekatvaṃ.*' End of Sūtra 50. *Sūtra 51* (*godhana*): '*gavāṃ viśeṣa kartavyaṃ.*'
3	60^r	Ex. 1 for Sūtra 51. Refers to the nineteenth leaf. End of Sūtra 51. *Sūtra 52* (*āyavyaya*): '*āyavyayaviśeṣaṃ tu.*' Ex. 1 for Sūtra 52.
4	60^v	Continues Ex. 1 for Sūtra 52. End of Sūtra 52. *Sūtra 53* (*dhanasāmyatā*): '*ahadravya harāśau ta.*' Mathematically equivalent to Sūtra C2 on 31^r (I 9) above. Ex. 1 for Sūtra 53.
5	61^r	Continues Ex. 1 for Sūtra 53. Ex. 2 for Sūtra 53.
6	61^v	Continues Ex. 2 for Sūtra 53. End of Sūtra 53. *Sūtra 54* (*krayavikraya*): '*vikrayena krayaṃ bhājyaṃ.*' Ex. 1 for Sūtra 54.
7	62^r	Continues Ex. 1 for Sūtra 54. End of Sūtra 54. *Sūtra 55* (*krayavikraya*): '*vikrayaṃ bhājaye caiva.*' Ex. 1 for Sūtra 55.
8	62^v	Continues Ex. 1 for Sūtra 55. End of Sūtra 55. *Sūtra 56* (*krayavikraya*): '*vikrayaṃ bhājaye caiva.*' Ex. 1 for Sūtra 56.
9	63^r	Continues Ex. 1 for Sūtra 56. End of Sūtra 56. *Sūtra 57* (*krayavikraya*): '*vikrayaṃ ca vibhaktavyaṃ.*' Ex. 1 for Sūtra 57.
10	63^v	Continues Ex. 1 for Sūtra 57. End of Sūtra 57. *Sūtra 58* (*vastraśulka*): '*vastraśulkaṃ yad bhavati.*' Ex. 1 for Sūtra 58.

Section IX

This section could be included in Section X. See the statement, '*evaṃ sarva trairāśikena*' (Thus, everything is ⟨calculated⟩ by means of the *trairāśika*) on 43^v. In that case, the position is probably just after fol. 49, since fols. 49 and 44 have a similar knot. The 'find order' also suggests that se-

quence, but the examples of this section presuppose a *sūtra* identical with, or equivalent to, Sūtra 52 on 60^r (VIII 3) above.

1	44^v	Ex. 1 for *Sūtra C9* (*āyavyaya*). Equivalent to Sūtra 52.
2	44^r	Continues Ex. 1 for Sūtra C9. Ex. 2 for Sūtra C9.
3	43^r	Continues Ex. 2 for Sūtra C9.
4	43^v	Continues Ex. 2 for Sūtra C9. Ex. 3 for Sūtra C9(?).

Section X

This section consists of a number of examples for *trairāśika* or the rule of three.

1	49^v	Ex. 1 for *Sūtra C10* (*trairāśika*). A time-weight *trairāśika*.
2	49^r	Continues Ex. 1 for Sūtra C10. Ex. 2. A weight-money *trairāśika*: donation to a goddess. The size and shape connect fol. 49 and fol. 55.
3	55^r	Ex. 3. A weight-money *trairāśika*.
4	55^v	Broken enclosure. Ex. 4. A weight-money *trairāśika*.
5	20^r	Ex. 5. A weight-weight *trairāśika*: gold. Ex. 6. A weight-weight *trairāśika*: gold. End of '*suvarṇasya māṇa*' (measurement of gold). Ex. 7. An arc(?)-time *trairāśika*.
6	20^v	Ex. 8. A length-time(?) *trairāśika*. Ex. 9. A length-time *trairāśika*: a moving snake. Ex. 10. A length-time *trairāśika*: a moving worm.
7	33^r	Ex. 11. Not understood. Ex. 12. A number-money *trairāśika*: instruction fees to gurus. Ex. 13. An area-number *trairāśika*: hairs on skin.
8	33^v	Ex. 14. A weight-time *trairāśika*. Ex. 15. A length-time *trairāśika*: a man climbing Mount Meru.
9	32^r	Ex. 16. A length-number *trairāśika*: a garment thrown by Sītā. Based on the episode of Sītā's abduction by Rāvaṇa told in *Rāmāyaṇa* 3.52.1–5. Ex. 17. A length-time(?) *trairāśika*: a snake.
10	32^v	Ex. 18. A length-time *trairāśika*. Probably Ex. 18 = Ex. 17. Ex. 19. A length-time *trairāśika*: a garment dropped from Brahmaloka. Fols. 32 and 36 have the same large knot.
11	36^r	Ex. 20. A time(?)-length *trairāśika*. End of '*deśapramāṇa*' (distance?). Ex. 21. A number-weight *trairāśika*: a lump of salt. Ex. 22. A time-money *trairāśika*: donation by a man.
12	36^v	Broken enclosure and an answer(?). Ex. 23. A length-time *trairāśika*: a moving worm. Ex. 24. A length-time *trairāśika*: a sailing boat.
13	34^r	Broken enclosure. Ex. 25. A weight-number *trairāśika*: birds eating grain.

		Ex. 26. A time-weight *trairāśika*: gold donated to Śiva.
14	34^v	Ex. 27. A length-number *trairāśika*: arrows shot by Arjuna.
		Ex. 28. A weight-money *trairāśika*: price of a diamond.
15	37^r	Ex. 29. A time-length *trairāśika*: the sun's motion.
		Ex. 30. A time-length *trairāśika*: the sun's motion.
16	37^v	Ex. 31. A time-arc *trairāśika*: Jupiter's motion.
		Ex. 32. A time-arc *trairāśika*: Saturn's motion.
		Ex. 33. A *trairāśika*(?): Yudhiṣṭhira.
17	41^v	Ex. 34. A money-weight(?) *trairāśika*. Elaborates the reduction of fractions. Cites Sūtra Q6.
18	41^r	Ex. 35. A double *trairāśika* (number-money and money-time): livelihood of seventy men.
19	65^r	Probably continues Ex. 35.
		Ex. 36. A double *trairāśika* (number-money and money- time): livelihood of seventy *pākarākṣakas*.
		Fol. 65 is a double leaf. See VII 1 above.
20	48^r	Ex. 37. A time-weight *trairāśika*.
21	48^v	Ex. 38. A double *trairāśika* (number-weight and time-weight): gold begged by eight thousand men.
		Ex. 39. The only legible word is '*śirase*.'
22	47^v	Ex. 40. A number-number *trairāśika*: arrows. Probably Ex. 40 = Ex. 39.
		Ex. 41. A number-number *trairāśika*: arrows destroying four *akṣauhiṇīs* of army.
		Ex. 42. Four number-number *trairāśikas*: size of an *akṣauhiṇī*. This is called a '*sūtra*' in the manuscript, but certainly is not. The verse is a verbatim quotation from *Mahābhārata* 1.2.15-19a.
23	47^r	Continues Ex. 42.
		Ex. 43. Contains the name of a prince, Śatrudamana.
24	42^r	Ex. 44. A weight(?)-money *trairāśika*. Solved by means of several methods including '*pratyekamūlyavidhi*.'
25	42^v	Continues Ex. 44.
		Ex. 1 for Sūtra Q11 (called 'another's method' for *trairāśika*). A time-money *trairāśika*.
		Mention of another method for *trairāśika*. This probably refers to Sūtra N19 on 50^v below.
26	50^v	*Sūtra N19* (*trairāśika* with vertical arrangement of the three terms).
		Ex. 1 for Sūtra N19. A money-number *trairāśika*: tin.
		Ex. 2 for Sūtra N19. A money(?)-number *trairāśika*. Cites Sūtra Q5.
27	50^r	Broken enclosure.
		Colophon in prose. Contains three proper names, namely, Vasiṣṭha, his son Hasika, and Chajaka.
		Gaṇitapraśaṃsāśloka (eulogy of mathematics).

CHAPTER 3

Script

The BM is written in the Śāradā script, which was developed from the north-western type of the Gupta script. The oldest known document in the Śāradā script is a stone slab inscription from Hund (Attok district, Pakistan) dated Saṃvat 168, which, as has been pointed out by D. R. Sahni, most probably refers to the Harṣa era of A.D. 606 and corresponds to A.D. 774/775.[1] The script is known to have been used in a relatively wide area. The find spots of the Śāradā inscriptions so far discovered spread over North-West India, including the northern part of Pakistan (ancient Gandhāra), Ladakh, Jammu, Kashmir, Chamba, Kangra, and even Delhi;[2] in Kashmir the script continued to be used until quite recent times.[3] The script is also used on Kashmir coins of the ninth to the thirteenth centuries.[4] Unfortunately, however, old manuscripts in the Śāradā script have rarely been preserved to this day, due no doubt to the fragile nature of the writing materials (birch-bark) used in those districts.

A detailed palaeographical study of the Śāradā inscriptions found in Chamba has been made by J. Ph. Vogel, who tried to trace the developments of that unusually conservative script.[5] One of his most convincing and important results is that the history of the Śāradā script can be divided into two periods — before and after the thirteenth century, which palaeographically forms a blank in Chamba.[6] On the basis of Vogel's study, G. R. Kaye compared the script of the BM with that of the Chamba inscriptions, and assigned it to the twelfth century.[7] Recently, B. K. K. Deambi conducted a research on the history of the Śāradā script, mainly based on the inscriptions found in Kashmir, Jammu, and Ladakh. He also treated in the same work several Śāradā manuscripts including the BM, and came to the same conclusion as Kaye's with regard to the date of the script in it.[8]

It may appear to be significant that the two scholars, Kaye and Deambi, have arrived at the same result by comparing the script with different materials, that is, Kaye with the Chamba inscriptions and Deambi with the Kashmir inscriptions. Their arguments, however, have a weak point in common, for their comparative studies were obliged to be based only on the inscriptions, as the BM is in reality the oldest Śāradā manuscript so far discovered.

A Śāradā manuscript "of the 12th century," which contains a work on Sanskrit grammar, is

1 Sahni 1933/34.
2 Vogel 1911, 43–46, and Deambi 1982, 3.
3 Deambi 1982, 3.
4 Cunningham 1894b, Plates IV and V.
5 Vogel 1911, 42–68.
6 Vogel 1911, 47.
7 Kaye 1927/33, 75–78 and 87–99.
8 Deambi 1982, 67–70. Vogel 1911 refers to the BM several times, but is wisely silent about its date.

Table 3.1: Supplementary List of Letters

Initial *i*	[illegible] (besides [illegible])	I 14 (28^v)
kṝ	[illegible]	VIII 10 (63^v)
ggrū	[illegible]	III 1 (1^r)
ghna	[illegible] (besides [illegible])	X 22 (47^v)
ṅtyā	[illegible]	V 2 (38#3^r)
śu	[illegible] (besides [illegible])	III 27 (14^r)
hva	[illegible]	III 17 (9^r)

said to have been discovered in Tibet, but no details are known.[9] The Śāradā manuscript of the *Munimatamaṇimālā* preserved in Srinagar palaeographically belongs to the fourteenth century, according to Deambi.[10] The Śāradā manuscripts of the *Mahābhārata* (Ādi- and Sabhā-Parvans),[11] *Śākuntala*,[12] and *Kathāsaritsāgara*[13] have been assigned to the sixteenth century on the palaeographical grounds by Deambi.[14] The Śāradā manuscript of the *Atharvaveda* (Kashmirian Paippalāda recension) preserved in Tübingen is said to belong to some time after the fourteenth century.[15] One of the three fragments in the Śāradā script found in Turfan was conjectured by E. Sieg to belong to the ninth or tenth century.[16] But L. Sander, after a detailed palaeographical study, placed all the three fragments after the thirteenth century.[17] Thus, we have no Śāradā manuscripts to be meaningfully compared with the BM, the script of which cannot be dated after the thirteenth century.

It is well known that in any culture legal (or formal) documents tend to preserve old letter forms which have become obsolete. As the same principle is naturally expected to hold in India also, we should not hasten to accept the conclusions of Kaye and Deambi, although the script of the BM certainly best resembles that of those inscriptions which are dated in the eleventh to twelfth centuries.[18] All that we can safely say is that the twelfth century is a lower limit for the date of the script.

As for the individual letter forms of the BM, I have little to add to Kaye's analysis, but there are some letters that have escaped him. Table 3.1 shows those to be added to his tables of letters.[19]

As has been pointed out above (Sec. 2.2), Kaye's classification of the writings in the BM is based on an insufficient, careless study of the manuscript; most of the apparent differences, even when they have been correctly noticed by Kaye, are probably due to the condition of the writing

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9 Deambi 1982, 70.

10 Deambi 1982, 70–76: Ms. No. 201 in the Mss. Library of the Research Department of the Jammu & Kashmir Government.

11 Ms. No. 159 of 1875/76 in the Bhandarkar Oriental Research Institute, Bombay.

12 Ms. No. 192 of 1875/76 in the Bhandarkar Oriental Research Institute, Bombay.

13 Mss. in the Library of the Research Department of the Jammu & Kashmir Government.

14 Deambi 1982, 76–80.

15 Bloomfield and Garbe 1901.

16 Sieg 1908, 183: Mss. Nos. 644, 1200, and 1201 in the Turfan Collection of Berlin.

17 Sander 1968, 161–171.

18 Deambi 1982, 88, refers to the same principle, but he does not take it into account when he compares the BM and the inscriptions.

19 Kaye 1927/33, Tables i–iv inserted in between p.100 and p.101.

materials, and to the mood of the scribe as he worked.[20] Kaye is, however, probably right in differentiating two styles, α and β. The former is, according to him, used in his A to L sections, and the latter exclusively in his M section. These two parts correspond respectively to Sections I to VIII and Sections IX and X in my revised order, except that Section X contains Kaye's J2 and J3 also. As Kaye has shown through his analysis of the medial vowels, style β contains relatively older elements.[21] But this does not necessarily imply that the portion written in β is older than the rest; it may have been simply a matter of taste. Neither is there strong evidence to show that the BM consists of two different works, although we cannnot entirely rule out the possibility.

20 Kaye 1927/33, 11
21 Kaye 1927/33, 95-97.

CHAPTER 4

Linguistic Peculiarities

The following study of the linguistic peculiarities of the BM is meant to give a basis to my interpretations of its contents, and the linguistic analyses given here and there are not at all thorough. I simply thought it inevitable to list up its linguistic irregularities systematically in order to decipher the text having so many irregular Sanskrit words.

I must also admit that not all irregularities listed below may have linguistic significances: some of them are probably graphic errors due to the scribe(s), and some are probably orthographical, while others certainly represent genuine linguistic peculiarities caused by a dialect or dialects. It was sometimes difficult for me to distinguish them, especially when the phenomenon is unique.

From the linguistic point of view, therefore, the present study is admittedly no more than a starting point, but it will exhibit a number of phenomena that are interesting to linguists. I hope this study and the transliteration of the text will be useful for them.

The symbol $>$, used as A $>$ B in the item-headings of the lists given below, indicates that A is the Sanskrit equivalent of B that occurs in the BM, and it does not necessarily signify the historical derivation of B from A. The symbol = signifies, as usual, equivalence of two words, two phrases, or two sentences, but it is also used to indicate an inorganic sound like '*m*' in '*sva=m=ardho.*'

Abbreviations of the titles of the works consulted

BHSD: *Buddhist Hybrid Sanskrit Grammar and Dictionary* by F. Edgerton, Vol. 2: Dictionary.

BHSG: *Buddhist Hybrid Sanskrit Grammar and Dictionary* by F. Edgerton, Vol. 1: Grammar.

B–R: *Sanskrit Wörterbuch* by O. Böhtlingk and R. Roth.

Geiger: *Pāli, Literatur und Sprache* by W. Geiger.

HGA: *Historical Grammar of Apabhraṃśa* by G. V. Tagare.

LM: *The Language of the Mahānayaprakāśa: An Examination of Kāshmīrī as Written in the Fifteenth Century* by G. A. Grierson.

MMW: *A Sanskrit-English Dictionary* by M. Monier-Williams.

Pischel: *Grammatik der Prakrit-Sprachen* by R. Pischel.

Other abbreviations used in this chapter

abl. = ablative	m. = masculine
acc. = accusative	M. = Mahārāṣṭrī
AMg. = Ardhamāgadhī	m.c. = metri causa
Ap. = Apabhraṃśa	Mg. = Māgadhī
comp. = compound	n. = neuter
d. = dialect	nom. = nominative
dat. = dative	opt. = optative
du. = dual	Pkt. = Prakrit
f. = feminine	pl. = plural
gen. = genitive	S. =Śaurasenī
impv. = imperative	sg. = singular
inst. = instrumental	Skt. = Sanskrit
JM. = Jaina Mahārāṣṭrī	voc. = vocative
loc. = locative	

4.1 Phonetics (and Orthography)

4.1.1 Vowels

- *Dropping of initial a.* *naṃtaraṃ* (VII 13, m.c.) = *anantaraṃ*; *sau* (X 8, m.c.) = *asau*; *sya* (VIII 7, IX 3, both in prose) = *asya*; *tu ṣṭādaśa* (V 3, this may be a graphic error. So may be the next.) = *tv aṣṭādaśa*; *tu* ⟨*nīkinī*⟩ (X 23, in a quotation from the *Mahābhārata*) = *tv anīkinī*. Cf. Pischel 142, Geiger 66, HGA 29, and LM 1.
- *Dropping of final a.* *pal* (X 20, 21, *la* with *virāma*) = *pala*. Cf. the dropping of final *ā* below.
- *Addition of medial a.* *ghana* (VII 1, twice) = *ghna*. In one of the two cases, the letters *gha* and *na* are combined with a hyphen-like stroke, which probably indicates a correction. *vajara* (IX 3) = *vajra*. Cf. Pischel 132, who cites S. *sattuhana* = *śatrughna*, Geiger 31.1, and BHSG 3.99–101.
- *a* > *ā*. *ārja* (VIII 3) and *ārjana* (IX 1) = *arjana*; *āṇḍikā* (X 4) = *aṇḍikā*; *ārdhāṃgulaṃ* (? X 6) = *ardhāṅgulaṃ*; *mekāsya* (VIII 5) = *ekasya*; *āṃbu* (V 2, in comp. '*madhvāṃbupayaso*'); *bāhu* (X 13, in prose) = *bahu*. Cf. Pischel 65, Geiger 24, HGA 26(A), BHSG 3.9–11, and LM 5. For *ārja* and *ārjana*, cf. *ārjanā* in BHSD.
  Final *a* > *ā*: *babhūvā* (III 31), which begins an odd *pāda* with a *pathyā* foot. Cf. BHSG 3.8. For the lengthening of final *a* of prior member of comp., see Sec. 4.1.3 below.
- *a* > *i*. *parimāśrayaṃ* (X 8); *prasthi* (III 26). For the former, cf. Geiger 19.1, who cites *parima*, Pischel 101, who cites *uttima* = *uttama*, HGA 22, BHSG 3.89, and LM 6.
- *a* > *u*. *paṃtu* (I 15) = *pañca*. This might be related to the dialectical change of *a*-stems into *u*-stems in Pkt. and Ap., if it is not a graphic error. See *aṃ* > *u* and *aḥ* > *u* below. Cf. Pischel 105 and HGA 19(2).
- *a* > *ai*. *cai* (II 4) = *ca*. Cf. *cā* = *ca* in BHSG 3.6.

- *ā > a.* *maśaka* (III 35) = *māṣaka*; *sakhya* (X 27) = *saṃkhyā*; *hitva* (III 35) = *hitvā*. Cf. BHSG 3.31 and LM 10 and 11 for non-final *ā*. Cf. BHSG 35.10 for gerunds.
- *Dropping of final ā.* *kal* (X 2, *la* with *virāma*) = *kalā*. Cf. the dropping of final *a* above.
- *ā > e.* *ucyatem* (VII 1). A graphic error?
- *ām > a.* *ucyata* (III 6) = *ucyatām*. A graphic error?
- *i > a.* *akṣāhanī* (X 23) = *akṣauhiṇīṃ*; *upara* (I 10, etc.) = *upari*; *uparāda* (X 17) = *uparyādi*; *yuta* (II 7, '*eṣāṃ yuta*') = *yuti*; *vrīhaka* (I 3) = *vrīhika*. Cf. Pischel 115, Geiger 17b, HGA 19(3) & 22, and LM 15–17.
- *i > e (probably short).* *pāteta* (VII 7). Cf. *maṇaleā* (V 6) = *maṇḍalikā* = *maṇḍalaka* (V 6). Cf. also Ṭagare's remark (HGA 15): 'The Northern scribes have a tendency to represent short *ĕ* and *ŏ* as *i* and *u*.'
- *ī > e.* *vekṣa* (III 27) = *vīkṣa*; *śveya* (X 25) = *svīya*. Cf. Geiger 11, HGA 28(ii), and BHSG 3.59.
- *u > a.* *niyata* (X 10) = *niyuta*; *āpnayā* (III 35) = *āpnuyāḥ*. Cf. Geiger 16d and LM 22.
- *u > ū.* *ūṣṭhra* (III 5) = *uṣṭra*; *mūkhyair* (X 2). Cf. HGA 28(ii) and BHSG 3.26.
- *ṛ > ra.* *praṣṭa* (I 8, VII 11, VIII 2, 3). Cf. Geiger 13. See Sec. 4.6.5 below.
- *ṛ > ri.* *riṇa* (II 1, etc.); *driṣya* (VIII 3) = *dṛśya*. For initial *ṛ > ri*, cf. Pischel 56, HGA 16, BHSG 3.94, and LM 25.
- *ṛ > ru.* *sruṇusva* (III 34) = *śṛṇuṣva*. Cf. BHSG 3.96.
- *e > ā.* ⟨*ādi*⟩*sāt* (VIII 9) = *ādiśet*. A graphic error?
- *e > i.* *niyo* (III 16); *prakṣipe* (IV 4). Cf. *avinīya* = *avineya* in BHSG 3.48 and 34.27.
- *e > ai.* *aiko* (III 16); *pratyaika* (II 6, III 5, IV 3); *rāśaikā* (X 16) = *rāśyekāṃ*; *uttaraiṇa* (III 9). Cf. BHSG 3.69.
- *ai > e.* *hehaya* (X 22). Cf. Pischel 60 and Geiger 15.
- *ai > o.* *hayor* (III 16); *-tulyoś* (III 27). A graphic error?
- *o > e.* *viśeddhya* (III 14). A graphic error?
- *au > ā.* *akṣāhanī* (X 23) = *akṣauhiṇīṃ*. A graphic error?
- *au > o.* *akṣohiṇī* (X 23). Cf. Pischel 61[a], Geiger 15, BHSG 3.78, and LM 33.
- *ṃś > ṅś.* *aṅśa* (I 2, III 1, VII 5); *catvāriṅśa* (VII 2) = *catvāriṃśat*; *tṛṅśa* (I 4, VIII 3) = *triṃśat*; *tṛṅśat* (X 19); *dvātṛṅśa* (III 20); *paṃcaviṅ*⟨*śa*⟩ (VII 8).
- *Dropping of anusvāra.* *sakhya* (X 27) = *saṃkhyā*; *harāśau* (VIII 4) = *harāṃśau*. These examples may be graphic errors, but the loss of the *anusvāra* (for final *m*) is common in case-endings. See Sec. 4.2.5 below. See also *ṅkt > kt* in Sec. 4.1.2 below. Cf. Pischel 350.
- *Addition of anusvāra.*
  Before *t*: *sūṃtraṃ* (III 6).
  Before nasals: *utpaṃnna* (X 27, twice); *dhvāṃnte* (III 19) = *dhvānte* = *dhmāte*; *ṣpṛṣaṃnti* (X 14) = *spṛśanti*; *draṃmmā* (X 18).

- *aṃ > u.* *jātu* (III 27); *dhanu* (VII 8); *padu* (VII 8). Cf. Pischel 351, BHSG 3.58, and LM 8.
- *iṃ > in.* *yutin* (III 32, 33). Cf. BHSG 2.66.
- *Dropping of visarga (or its equivalents, r and s).* Occurs very often in case-endings (Sec. 4.2.5) and in indeclinables (Sec. 4.5).
- *aḥ > u.* *dinu* (I 18); *prasthu* (III 23). Cf. Pischel 346, BHSG 3.52, and LM 7.
- *aḥ > o.* *ato* (I 17, etc.); *tato* (III 2); *vastrato* (VIII 10). Cf. Pischel 345.

4.1.2 Consonants

- *Doubling of consonants.* This phenomenon occurs, both internally and externally, between a vowel/nasalized vowel and a vowel/semi-vowel.
  Internally: *anukkrameṇa* (VI 3); *paṃcca* (X 1); *koṭṭi* (X 10); *piṇḍḍa* (II 10); *attra* (I 7); *ekattra* (I 1, etc.); *cittṛta* (X 14) = *citrita*; *pattre* (III 7); *sarvattra* (I 3); *katthyatāṃ* (III 11, etc.); *addhyardha* (III 6, 21); *gṛddhra* (X 14); *maddhva* (III 23) = *madhvāḥ* (gen. sg. f.); *-śoddhya* (II 9, etc.). Cf. HGA 72.
  In comp.: *mākṣikagghaṭaka* (III 31); *dinattṛbhāgena* (X 12) = *dinatribhāgena*; *dinattraye* (IX 2); *nṛpatissevya* (VIII 5).
  Externally: *pṛthagg rūpa-* (III 1); *tatra ttrayodaṣa* (VI 1); *prājña ddhvānta-* (III 29); *hayā nnava* (III 5); *ṣṣaḍ* (I 12, etc.); *ssapta* and *ssaptati* (III 11, etc.); *ssama* (I 9, etc.); *ssaha* (III 11); *ssyād* (VI 2). Cf. BHSG 2.78–82.
- *Reduction of double to single consonants.*
  tt > t: *utara* (X 12); *utpati* (IX 2, the meter prefers *utpatti*); *dataṃ* (X 21); *pati* (X 23); *pravṛti* (III 19).
  mm > m: *dramam* (X 3). Cf. BHSG 2.84–89.
- *Dropping of final consonants.* This is common in case-endings (Sec. 4.2.5), in indeclinables (Sec. 4.5), and in the 3rd sg. opt./impv. of verbs (Sec. 4.6.4). Cf. BHSG 2.90–92 and LM 54–55.
- *Dropping of g.* *dūnā* (I 3) = *dviguṇāḥ*; *bhāṃś ca* (III 33) = *bhāgaś ca*. Cf. Pischel 184 & 186 and HGA 56(2).
- *gdh > ndh.* *dandha* (III 19).
- *gh > h.* *saṃha* (X 15). Cf. Pischel 188, Geiger 37, HGA 57(2), and BHSG 2.35.
- *ṅkt > kt.* *bhukte* (X 16). Cf. the dropping of the *anusvāra* (Sec. 4.1.1).
- *ṅkty > ṅty.* *paṅtyā* (V 2, twice) = *paṅktyāḥ*.
- *cch > ts.* *tsedaṃ* (II 9); *tatseṣā* (II 9) = *taccheṣāt*. Cf. *ts > cch* below. Cf. also BHSG 2.19, which explains this phenomenon as hyper-Sanskrit.
- *jñ > j.* *jātaṃ* (IV 9). A graphic error? Or, *jñ- > jj- > j-*? Cf. *jñ > jj* in Pkt. (Pischel 276).
- *jy > jj.* ⟨*vāṇi*⟩*jjakasya* (III 26). Cf. Pischel 279 and BHSG 2.8.
- *ñc > ṅc.* *paṅca* (III 10).
- *ñc > ṃt.* *paṃtu* (I 15).

- *ṭk > ḍg? ṣa⟨ḍ⟩gā* (VIII 5) = *ṣaṭkā*? Cf. Geiger 61.
- *ṇ > n. akṣāhanī* (X 23) = *akṣauhiṇīṃ*; *una* (I 3, in '*dūnā*') = *guṇa*; *panyaṃ* (X 26); *lavanasya* (X 11); *dīnārenāsti* (X 2) = *dīnāreṇāsti*. Cf. *n > ṇ* below. Cf. also Pischel 225 & 243, BHSG 2.39, and LM 41.
- *ṇ > r. kararena* (III 9) = *karaṇena*. Cf. *r > ṇ* in AMg. (Pischel 258).
- *ṇḍ > ṇ. maṇaleā* (V 6) = *maṇḍalikā* = *maṇḍalaka* (V 6). Probably *ṇḍ > ṇṇ > ṇ*.
- *tt > nn. trikonnaraḥ* (III 8).
- *ttv > tv. datvā* (III 6, etc.)
- *tm > p. āpa* (I 4). Cf. LM 76, which cites the same word. Cf. also M. and Ap. *appa-* < Skt. *ātman* (Pischel 277).
- *tv > nv. canvāri* (I 7).
- *ts > cch. vecchi* (VI 1, 2). Cf. *cch > ts* above. Cf. also Pischel 327 & 327[a], Geiger 57, and BHSG 2.18.
- *dīn > nī. tadānī* (VI 2) = *tadādīn*. A graphic error?
- *dr > ḍh. sūḍha* (VII 12) = *śūdra*. Cf. *dr > ḍḍ* in Pkt. (Pischel 294).
- *dvi > du. dūnā* (I 3) = *dviguṇāḥ*. Cf. Pischel 152 & 436, HGA 63(A), and LM 120.
- *dh > th. thā* (X 20) = *dhā* (abbreviation of *dhāṇa* = *dhānya*). Cf. Pischel 191 and Geiger 29.5.
- *dhm > dhv. dhvānta* (III 19, 29). Probably a false Sanskritization from *dhānta* (III 19, etc.) = *dhmāta*. See Sec. 4.7.1 (s.v. *dhānta*).
- *dhy > ṃdy? śuṃdyati* (X 1) = *śudhyati*?
- *n > ṇ. āṇanaḥ* (X 9); *āṇīta* (III 24); *guṇanaṃ* (IV 7); *paramātmaṇ⟨ā⟩* (X 27); *pavaṇe* (X 9) = *pavanena*; *hīṇāḥ* (III 8); *patamāṇā* (X 9); *⟨saṃ⟩(pū)yamāṇasya* (X 15). In case-endings: *bhāgāṇi* (X 5); *⟨tā⟩ṇi* (I 1); *adheṇa* (X 26); *ardheṇa* (III 2, 15); *caturtheṇa* (IV 9); *m⟨ū⟩l⟨y⟩eṇa* (V 6); *śiveṇa* (X 27); *rāśīṇāṃ* (X 5); *viliptāṇāṃ* (X 16); *saptāṇāṃ* (X 11); *sārdhāṇāṃ* (X 8). See *ṇ > n* above. Cf. Pischel 224 and Geiger 42.5.
  nn > ṇṇ: utpaṇṇā (VIII 8); *saṃpaṇ⟨ṇa⟩* (X 24). Cf. BHSG 2.40.
  ny > ṇy: ṇyastaṃ (IV 5, 6); *ṇyasya* (VI 1); *śūṇya* (I 7, etc.).
- *Final n > ṃ. dattavāṃ* (X 13); *pumāṃ* (X 13); *mahātmavāṃ* (X 22) = *mahātmavan* (voc.). Cf. Pischel 348.
- *ny > ṇ. dhāṇa* (X 2,20,21).
- *ny > ṇy.* See under *n > ṇ* above.
- *pr > p. pārtha, pāsta*, and *pāstha* (III 19, etc.) = *prāsta*. Cf. Pischel 268 & 287, HGA 64, and LM 110.
- *Addition of m before eka. mekāsyāhne* (VIII 5, begins a line of a Śloka) = *ekasyāhne*. Cf. the *sandhi*-consonant *m* (Sec. 4.1.3).

- *Dropping of y after consonants* (through assimilation). *vākṛtāṃ* (X 11) = *vyākṛto*; *rāśaikā* (X 16) = *rāśyekāṃ*; *rāṣeko* (X 11) = *rāśyeko*; *kathatāṃ* (III 21) = *kathyatāṃ*. Cf. initial *vy* > *v* (Pischel 286 and Geiger 54.6), *śy* > *ss* or *s* (Pischel 315), and *thy* > *tth* (Pischel 280) in Pkt.; *ṣy* > *s* in BHSG 2.89; and *śy* > *ś* in LM 124.

- *Addition of y.* *lagyanti* (X 19); *śeṣya* (III 28); *vinyasye* (IV 4) = *vinyaset* (the meter prefers this form). For the stem *lagya-*, see Sec. 4.6.3 below.

- *Addition of r.*
  Before and after *g*: *dhāntaśo rguṇātaḥ* (III 23) = *dhāntaśo guṇāt*; *vargraṃ* (IV 5) = *vargaṃ*.
  Before *bh*: *rbhāṇo rathaṃ* (X 15, begins a Śloka) = *bhāno rathaṃ*.
  Before *l*: *jātā rlabdha* (III 18); *bhajitā rlabdhaṃ* (II 7); *bhājaye rlabdha* (X 26); *śataṃ r-la⟨b⟩dha⟨ṃ⟩* (X 26); *bhave rlābhāḥ* (VIII 6).
  Before and after *v*: *cayaśuddhirvibhājitaṃ* (III 8, comp.); *vriyogaṃ* (II 2).
  Before and after *h*: *vākṛtāṃ rharai* (X 11) = *vyākṛto haraiḥ*; *hrarā* (VIII 4) = *harān* (acc. pl.); *hrīṇaṃ* (VIII 2) = *hīnaṃ*. According to Pkt. grammarians, the addition of *r* as a second member of a consonant group is one of the distinguishing characteristics of Ap. See HGA 11(6) & 68.

- *r* > *l.* *catvāliṃśa* (I 3, etc.) and *cāli⟨ṃ⟩śa* (II 9) = *catvāriṃśat*. Cf. Pischel 256–257, Geiger 44, HGA 70(7), and BHSG 2.49.

- *l* > *r.* *karāṃśakaṃ* (III 33). Cf. Pischel 259, Geiger 45, HGA 70(7), and BHSG.2.49.

- *ri* > *ṛ.* *ucchṛtāṃ* (X 8); *kṛyate* (I 3, etc.; the normal form *kriyate* never occurs); *kṛyā* (III 19, V 6, X 17, 26); *cittṛta* (X 14) = *citrita*; *tṛ* (I 4, etc.); *tṛ(ka)* (IV 12); *tṛtaya* (III 15); *tṛṅśa(t)* (I 4, III 20, VII 13, VIII 3, X 19); *vimiśṛtaṃ* (VIII 8, the meter prefers *ri*). Cf. BHSG 3.95, which explains this phenomenon as hyper Sanskrit.

- *rī* > *ṛ.* *kṛṇāti* (VIII 6); *vikṛṇāti* (VIII 6, 7). For the stem *kṛṇā-*, see Sec. 4.6.3 below.

- *rī* > *ṝ.* *kṝte* (VIII 10) = *krīṇīte* (3rd sg.) or *krīte* (loc. of past participle).

- *Dropping of v.* *ūrdha* (I 10, etc.) = *ūrdhva*.

- *v* > *p.* *piṇyastaṃ* (IV 6) = *vinyastaṃ* (see *viṇyastaṃ* in IV 5). Cf. Pischel 191.

- *vy* > *dy.* *gadyūti* (III 23).

- *ś* > *ṣ.* *daśāṣ⟨vā⟩* (III 16); *daśāṃṣā* (III 20); *daṣa* (III 15, 23, IV 1, 2); *rāṣi* (II 1, III 10, 12, X 11); *anupūṛvaṣaḥ* (II 5); *ṣeṣa* (II 1, III 36); *sadṛṣe* (II 6).
  śy > *ṣy:* *dṛṣya* (I 3, etc.); *dṛṣyate* (III 28); *driṣya* (VIII 3) = *dṛśya*. Cf. BHSG 2.59.

- *ś* > *s.* *⟨ādi⟩sāt* (VIII 9) = *ādiśet*; *⟨rā⟩si* (X 11); *sruṇusva* (III 34) = *śṛṇuṣva*. Cf. Pischel 227, Geiger 35, HGA 54(1), and BHSG 2.63.

- *śn* > *ṣṇ.* *prasṇa* (II 5, etc.). A false Skt. form from d. *paṇha*. Cf. *śn* and *ṣṇ* > *ṇh* in Pkt. (Pischel 312 & 314) and *ṣṇ* > *ṇh* in Pali (Geiger 50.3).

- *śm* > *mbh.* *ambha* (III 28) = *aśma-*. Cf. *śm* > *mh* > *mbh* in Pkt. (Pischel 267 & 312) and in Pali (Geiger 50.2), and *ṣm* and *sm* > *mbh* in Ap. (HGA 67(4)). Cf. also *kumbhāṇḍa* (BHSD) = Pali & S. *kumbhaṇḍa* (Pischel 127) = Skt. *kuṣmāṇḍa* or *kūṣmāṇḍa*.

- *ṣ > ś.* *eśa* (I 2, etc.); *eśāṃ* (III 34); *puruśa* (II 2); *maśaka* (III 35) = *māṣaka*; *māśa* (III 33, 36); *māśaka* (III 15, etc.); *śaṭ* (X 3, 24, 25); *śaṣṭi* and *śaṣṭhi* (III 2, 3, VIII 8, X 18); *śoḍaśa* and *śoḍaṣa* (III 23, X 22); *bhāgeśv adha-* (I 10); ⟨*śū*⟩*ny*⟨*e*⟩*śu* (IV 10). Cf. Pischel 229, BHSG 2.57, and LM 52.
- *ṣ > s.* *e(sa)* (V 1); *saṣṭhi* (V 6).
  ṣv > sv: *sruṇusva* (III 34) = *śṛṇuṣva*. Cf. Pischel 228, Geiger 35, HGA 54(3), and BHSG 2.62.
- *ṣṭ > śt.* *śta* (IV 7) = *iṣṭa*. For the dropping of *i*, see '*e + i*' in Sec. 4.1.3.
- *ṣṭ > ṣṭh.* *aṣṭha* (III 7, etc.); *ūṣṭhra* (III 5) = *uṣṭra*; *śaṣṭhi* and *ṣaṣṭhi* (III 2, 3, 26); *śliṣṭha* (III 12, VII 1, 3, 6); *saṃśliṣṭha* (III 12, VII 3); *śṛṣṭhi* (X 27) = *sṛṣṭi*.
  ṣṭv > ṣṭhv: *dṛṣṭhvā* (III 35). Cf. *siṣṭha* (= *sṛṣṭiḥ*) in LM 129.
- *ṣṭh > ṣṭ.* *tiṣṭati* (X 27); *ṣaṣ(ṭa)* (V 3).
- *s > ś.* *aśau* (X 9); *nyāśa* (X 12); *śa* (III 1, pronoun); *śarva* (III 2); *śṛṣṭhi* (X 27) = *sṛṣṭi*.
  sv > śv: *vadaśva* (III 28); *śva* (X 9); *śveya* (X 25) = *svīya*. Cf. Pischel 229 and BHSG 2.58.
- *sk > kh.* *khandhake* (X 25). Cf. Pischel 268 & 306, BHSG 2.12, and LM 135.
- *sk > skh.* *skhandhakasya* (X 25). A false Skt. form from d. *khandhaka*. Cf. initial *skh > kh* in Pkt. (Pischel 306 and Geiger 52.2) and in BHSG 2.12.
- *st > rth.* *pārtha* (III 19) = *prāsta*. A false Skt. form from d. *pāsta* or *pattha*. Cf. *rth > st* in Mg. (Pischel 290).
- *st > sth.* *pāstha* (III 20, 28) = *prāsta*. A false Skt. form from d. *pāsta* or *pattha*. See *sth > st* below.
- *sth > sṭ.* *sṭāpanaṃ* (III 32).
- *sth > st.* *prasta* (III 6); *prastu* (III 23) = *prasthaḥ*. Cf. Pischel 310.
- *sp > ṣp.* *ṣpṛśaṃnti* (X 14) = *spṛśanti*. Cf. *ṣp > sp* in Mg. (Pischel 305).
- *Dropping of last syllable* (m.c.). *ārja* (VIII 3) = *ārjana* (IX 1) = *arjana*; *yoja* (X 12) = *yojana*.

4.1.3 Sandhi

- *a + a > a in comp.* *guṇabhyāso* (VI 4) = *guṇa-abhyāso*; *śaṭs*⟨*v*⟩*ardhasya* (X 24) = *ṣaṭ-sva-ardhasya*. Cf. BHSG 4.21 and LM 11.
- *Lengthening of final a, i, u of the prior member of comp.*
  a > ā: *uparimā-skhandhakasya* (X 25); *guṇā-kāra* (I 10); *palā-krīte* (III 21); *prasṇā-vidhi* (X 25). Cf. Pischel 70, Geiger 33, BHSG 8.15, and LM 11. *tṛguṇā-tṛguṇena* (I 4) and *dviguṇā-dviguṇaṃ* (II 7) are *āmreḍita* comp. On the analogy of *aṣṭādaśa*: *saptādaśa* (VI 2); *saptāviṃśa* (III 28). The following instances of *a > ā*, and *i > ī* (and *u > ū*?) may be interpreted as nom. pl. forms used in comp. (see Secs. 4.2.4 and 4.2.5).
  a > ā: *kanakā-yuti* (III 32); *tṛcatuḥpaṃcakā-kṣayai* (III 28); *divasā-viṃśatikaṃ* (X 1); *bhāgā-guṇitā* (V 4).
  i > ī: *koṭī-śatārdha* (X 15); *rāśī-dvaya* (X 17); *rāśī-saṃyutaṃ* (II 8). Cf. BHSG 10.9 & 10.11. Cf. also *koṭīśataṃ* in BHSD (s.v. *nayuta*).
  u > ū: *madhū-ghaṭa* (V 2). Cf. *madhū-payasaṃ* in BHSG 12.6.

- *Dropping of final i before vowels in comp.* *uparāda* (X 17) = *upari-ādi*. See also the dropping of *y* in Sec. 4.1.2 above.
- *ā + e > ā.* *sākaikena* (X 9) = *sā + ekaikena*. A graphic error?
- *e + i > e.* *śūṇyeśta* (IV 7) = *śūnye + iṣṭa*. Cf. Pischel 175 and Geiger 71.1. Cf. also *e + u > a + u > o* in BHSG 4.37.
- *ṃ > n before t.* *viśeṣan tu* (VIII 3). Cf. BHSG 2.65.
- *m > ṃ before vowels.* The *anusvāra* is often used for *m* before vowels. To cite a few cases (in prose): *evaṃ ekādaśama* (III 7); *mūlaṃ ānayasva* (III 12); *anyaṃ asyą* (III 27). Cf. BHSG 2.68–70.
- *m > ṃm before vowels.* *bhāgaṃm apa-* (X 6); *saptānāṃm api* (X 11); *punānyaṃm ardha-* (I 9) = *punar anyam ardha-*; *phalaṃm iha* (I 4); *vibhaktaṃm uttareṇa* (III 7); *sarveṣāṃm eva* (X 27). Most of these cases occur either in prose or in metrically indifferent positions of verses. Probably this '*m*' has the same linguistic significance as the *sandhi*-consonant *m* (see below). Cf. BHSG 2.64, which takes this '*ṃm*' to be a mistake for *ṃ*.
- *r > m before m* (assimilation). *ādyadvitīyayom miśraṃ* (VI 1, 2).
- *Visarga.* The *visarga* is retained in a few cases before vowels and voiced consonants. *gantavyaḥ ā⟨kramya⟩* (III 18, *gantavyaḥ* in the acc. sg.); *⟨bha⟩ktāḥ dṛśyāḥ* (IV 8). Cf. BHSG 2.93. For characteristic use of the *visarga* in the BM, see Sec. 4.1.4 below.
- *Unvoiced consonants.* These are often retained before voiced consonants. To cite a few instances: *pṛthak rūpaṃ* (VI 4, twice); *ṣṣaṭ yojanāni* (III 18); *kacit dadāmi* (X 2).
- *t + ś.* The *t* is kept unchanged before *ś* in: *ūnāt śeṣa-* (VII 3).
- *Hiatus.* The *hiatus* occurs often both in verses and in prose sentences.
  In verses: Instances caused by meter are: *lohasya ekāśītiś* (III 30); *ṣṣaṭpaṃcāśa ṛṇaṃ kṛtaṃ* (VIII 9); *caiva udare* (V 5); etc. In metrically indifferent positions: *aṣṭau āṇīta* (III 24); etc. Even against meter: *ādi paṃca uttaraṃ trīṇi* (III 11).
  In prose: *saṅkaardhaṃ* (III 2, comp.); *jātāni aśvai* (III 5); *śeṣa atra* (III 18); etc.
- *Sandhi-consonants (or hiatus-bridgers).*
  d before *iti*: *kanakā=d=iti* (III 32); *kaṭī=d=iti* (III 35); *sthāpyate=d=iti* (III 22). Cf. BHSG 4.64 and Geiger 73.4.
  n: *labhate=n=aṣṭhau* (VIII 8). Cf. BHSG 4.65 and Geiger 73.6.
  m: *sva=m=ardho* (II 9); *prati=m=ahni* (X 2); *divardha=m=āṇḍikā* (X 4); *-paṇyāni=m=ānaya=ḥ* (I 15); *ca=m=utpaṃnnaṃ* (X 27); *bhṛtako=m=eka* (VIII 4); *tṛdvi=m=ekaḥ* (V 5); *dina=m=ekena* (X 21); *muhūrta=m=ekena* (X 15, the meter requires '*muhūrtaikena*'); *⟨tas⟩-ya=m=eka-* (III 18, in prose); *dvā(daśa)=m=eva* (IX 3); *ek⟨o⟩natṛ⟨ṃ⟩=m=eva ca* (VII 13, for '*ekonatṛṃśa=m=eva ca*'). See also *m > ṃm* above. Cf. Pischel 353, Geiger 73.2, and BHSG 4.59–60.
  r: *guṇasāmye=r=ayaṃ* (III 1); *ajñāta=r=ambhalohasya* (III 28) = *ajñātāśmalohasya*; *tṛ-=r=āśīti* (VII 13) = *tryaśīti*; *tṛ=r=ūnaṃ* (II 4); *tṛtaya=r=uttaraṃ* (III 15). Cf. Pischel 353, Geiger 73.3, and BHSG 4.61–63.
  Most instances of the *sandhi*-consonants, *n*, *m*, and *r*, cited above can be explained metrically,

but *muhūrta=m=ekena, tasya=m=eka-,* and *m=ekāsyāhne* (VIII 5) cannot. These three examples seem to indicate that '*meka*' was considered a word equivalent to *eka*. Cf. *ekameka* in BHSD and *ekameko* in Pali (Geiger 114.1).

4.1.4 Visarga and Its Equivalents

The symbol for the *visarga*, which consists of the two dots placed one below the other, occurs very often in the BM, but the innate *visarga* for final *r* and *s* rarely occurs, as these (*r* and *s*) are, like other final consonants, very often lost. When they are retained before the unvoiced gutturals and labials, they almost always become *jihvāmūlīya* (transliterated *ẖ*) and *upadhmānīya* (*ḫ*) respectively. Thus, the *jihvāmūlīya* occurs in: *bhṛtakaẖ kaści* (III 15), *duẖkha* (X 7), etc.; and the *upadhmānīya* in: *catuḫpaṃca* (VI 4), *yojanaḫpañca* (III 10), etc.

On the other hand, the symbol for *visarga* (*ḥ*) is often attached to the inflected words that occur at the ends of prose sentences: *palaṃḥ* (X 1), *mūlyaṃḥ* (V 6), *pratyayaṃḥ* (III 9), *kartavyaṃḥ* (VII 4), *kṛtaṃḥ* (VII 7), *paṃcaḥ* (VI 1), *trairāśikenaḥ* (I 3, III 7, 18), *kṛyateḥ* (I 3), *bhavantiḥ* (III 9), *lagyantiḥ* (X 19), and *bhavantuḥ* (X 27). It is also attached to the abbreviations of *dramma*: *draṃḥ* + numerical figures (I 10), and to the indeclinable *sarvatra*: *sarvatraḥ* (I 3). It is also used, side by side with *daṇḍas*, at the ends of lines of verses: *nnavaḥ* (III 5), *trayodaśaḥ* (X 5), *ttrayodaśaḥ* (VI 1), *paṇḍitaḥ* (III 20, VIII 4, in the voc. sg.), *budhaḥ* (VIII 4, in the voc. sg.), *pūrvagantunāḥ* (III 3), *mamaḥ* (VI 1), *kilaḥ* (III 1), *tathāḥ* (VIII 10, X 13), *vaiḥ* (VIII 5), *ānayaḥ* (I 15, III 36), *kuruḥ* (VIII 2, X 26), *vadaḥ* (III 27, 35), and *śabdavaḥ* (I 1, for *śabdaya*); and at the ends of cited *pādas*: *śliṣṭhaḥ* (VII 3), *datvāḥ* (IV 11), and *vinikṣipyaḥ* (V 1, VI 4). It is also used, side by side with *daṇḍas*, to separate the elements of comp.: *tadvargaḥdala/saṃśliṣṭha/hṛti* (III 12).

All these instances may suggest that the *visarga*-like symbol is used, just like the *daṇḍa*, as a mark for termination or a period.[1] This conjecture is, however, somewhat weakened by the fact that the same symbol is sometimes followed by the *daṇḍa* itself: *eṣālpasyaḥ //* (III 18, in prose, = *eṣo 'lpasya //*),[2] and *vamaḥ //* (II 4, for *vada* at the end of a Śloka). It is probable that the symbol is not only a graphic mark for termination, but also has the sound value, *ḥ*, which expresses the closing of a sentence or a phrase or a word. It is noteworthy that the *t* is also used as a terminal sound in: *jīvalokāt* (IV 2), *-dvayet, cayet, vait* (cf. *vaiḥ* cited above), *-trayet*, and *uttamet* (IX 2, 3, all at the ends of lines of a single verse).

Probably of different origin are the *jihvāmūlīya*, *upadhmānīya*, and the *s* that occur in: *labhyateẖkati* (X 26, twice), *gatvāḫprasthaṃ* (III 23), *kṣīyatestrayaṃ* (III 20), *bhāgenastathā* (III 26), *caturdaśastu koṭṭī⟨nāṃ⟩* (X 10), *asyaivaḫpraṣṇasya* (X 5), *caivaḫpatti* (X 22), and *nāmaḫpāṇḍu* (X 16). This seems to me to be a wrong resolution of reduplicated consonants: *kk* > *ẖk*, *pp* > *ḫp*, and *tt* > *st*. The same explanation may be applicable to the *t* and *d* that occur in: *jñāyatetpravṛttikāṃ* (III 28) and *dinaidvāṇijyakasya* (IX 3).

As for the form '*caturdaśastu*' cited above, it is also probable that the words in *-daśa* are inflected as *a*-stem nouns (see Sec. 4.4). Edgerton (BHSG 2.81) compares '*diśo daśaḥ sarva bhaveyu*

1 On the Chamba inscriptions, Vogel 1911, 57–58, remarks: 'The *visarga* and *anusvāra* do not present any particular features in Śāradā. The only point worth noticing is that, in several Chambā inscriptions composed in corrupt Sanskrit, the real meaning of the *visarga* is misunderstood and it is regularly used as a sign of punctuation to separate words and sentences.'

2 In some of the Gilgit Brāhmī inscriptions (Fussman 1978, Nos. 21.13, 25.1, and 27.14) occur words in *-syaḥ* (e.g., *atyavamasyaḥ*), which (inclusive of *ḥ*) has been interpreted by Humbach 1980, 113, as an ending for the gen. sg. of *a*-stem nouns.

pūrṇā' (*Saddharmapuṇḍarīka* 32.2) with '*kaṇṭakabhasmatṛnaśśayanānāṃ*' (*Śikṣāsamuccaya* 332.7), and remarks that the two spellings, *ḥs* and *śś*, 'obviously have essentially the same linguistic meaning.' For the form '*daśaḥ*,' cf. also BHSG 19.26.

4.2 Nouns

4.2.1 Number

Confusion in number is sometimes noticed in the BM. This is particularly so in duals. Cf. BHSG 5 and Geiger 77.1.

- *Sg. for du.* *gatisyaiva viśeṣaṃ* (I 17, III 6, 7); *uttarasya viśeṣataḥ* (III 7); *asya saṃyogaṃ* 111 (II 6, where '*asya*' refers to the two numbers, 99 and 12).
- *Pl. for sg.* *ghaṭikaiḥ* (X 15, 'in one *ghaṭikā*'); ⟨*śū*⟩*ny*⟨*e*⟩*śu* (IV 10, 'in the place of zero').
- *Pl. for du.* *eṣāṃ cchedāṃ kṛtā* (X 24, where '*eṣāṃ*' refers to the two numbers, 40 and 160); *guṇ*⟨*au pṛ*⟩*thagg rūpayutau yācanāyuktisaṃguṇāḥ* (III 1); *dvidhānakai dramam* (X 3); *dvinavabhāgesv* (I 10); *dvibhis* (VIII 7); ⟨*rā*⟩*japutro dvayo keci nṛpatissevya santi vaiḥ* (VIII 5). The following may also be included here (see Sec. 4.2.5.1 for the pl. endings, *-a*, *-aṃ*, and *-ā*). *krayavikraya saṃvartya* (VIII 9); *dvau paṭau hṛta śaulkikau* (VIII 10); *ahadravya harāśau* (VIII 4) = *ahardravyau harāṃśau*; *dvau ca prāptaṃ* (III 35); *catuḥpaṃcakā / aïtra kṣiptaṃ* (VI 4); *tatrottarā* 1 / 1 / (II 5).

4.2.2 Gender

Gender in the language of the BM shows extensive confusion probably due to the overlying dialect(s), in which, as in Pali (Geiger 76), Ap. (Pischel 359), BHSG 6.1–3, and LM 155, only vague distinction seems to have been made between the three genders (especially between the masculine and the neuter). Thus, the misuse of case-endings, from the view point of regular classical Sanskrit, is as common in the BM as in BHSG 6.5–7. For example:

- *m. for n.* *yojanāḥ* (III 16, nom. pl.).
- *m. or n. for f.* *śālais* (III 24, inst. pl.).
- *f. for m.* *yavā̦* (X 2, nom. sg.).
- *n. for m.* *yogaṃ* (V 2, nom. sg.).

We also find one and the same noun used in different genders side by side:

- *m. f. n.* *abhyāso, abhyāsā,* and *abhyāsaṃ* (VI 4, all in the nom. sg.).
- *m. n.* *ayaṃ kālo jñeyaḥ* (III 18), *tenaiva kālaṃ bhavati* (III 6), and *kiṃ kālaṃ* (VIII 3); *kṣayaḥ* (VII 3) and *kṣayaṃ* (III 33); *pratyayaḥ* (III 8) and *pratyayaṃ* (III 13); *eṣa lābhaḥ*, and *eṣa lābhaṃ* (both in VIII 8).
- *f. n.* *vrīhakā* and *vrīhakaṃ* (I 3).

Disagreement of gender between a noun and its attribute(s) is common, as in BHSG 6.11–20. To cite a few instances:

- *m. for f.* ⟨*sī*⟩*tā candranibhānanaḥ* (X 9); *akṛte śliṣṭakṛtyūnā* (VII 6) = *akṛteḥ śliṣṭakṛtyūnāt* (for -*ūnāyāḥ*).
- *m. for n.* *kaḥ kālaṃ* (IX 1, 3); *kaś ca lābhaṃ* (VIII 8); *sa rathaṃ* (X 15).
- *f. for n.* *jātā phalaṃ* (IV 3).
- *m. n. for n.* *canvāri* (*catvāri*, n.) *dattāḥ* (m.) (I 7, 'Four ⟨coins⟩(*rūpkāni*, n.) were given away').
- *f. n. for f.* *tatas tisra* (f.) *samādāya tulitāni* (n.) *trayodaśa* (I 1, 'Then, when one has taken three ⟨balls of flesh (*peśī*, f.)⟩, they weigh thirteen').
- *f. n. for n.* *brahma(lo)*⟨*ka*⟩*(pa)rīmuktā* (f.) *patitaṃ* (n.) *bhūmitale paṭaṃ* (X 10).

4.2.3 Case

Unusual use of the cases is sometimes noticed.

- *Inst. for nom.* *aṣṭhādaśayojanā* (acc. pl.) *ekena dine yāti* (III 7); *prathamena dvitīyasya* (gen. for dat.) *daśadīnāra* (acc. pl.) *dattavān* (VIII 5). Cf. BHSG 7.41.
- *Inst. for abl.* *eta caturdaśabhi śoddhya* (VI 1, 'This is to be subtracted from fourteen'). Cf. Pischel 369 & 381 and BHSG 7.36.
- *Abl. for inst.* *aśvai hayai ūṣṭhrībhyaḥ* (III 5, for *uṣṭraiḥ*). Cf. BHSG 7.46.
- *Suffix -taḥ in the inst. sense.* *uttarasya viśeṣataḥ vibhaktaṃ* (III 7).
- *Gen. for dat.* (indirect object). This is common (as in Skt.). Cf. Geiger 77.2 and BHSG 7.63.
- *Loc. for inst.* *hrarā hareṣu guṇayet* (VII 4) = *harān harair guṇayet*. Cf. HGA 12, 78, and 81, and BHSG 7.81.
- *Loc. for dat.* (indirect object). *caturthe caiva dattavān ... vadasva prathame dattaṃ kiṃ pramāṇaṃ* ⟨*para*⟩*sya* (gen. for dat.) *ca* (IV 4). Cf. BHSG 7.83.

4.2.4 Compounds

The prior members of compounds sometimes occur in their inflected forms, as in BHSG 8.12–17. *tṛtīyaścaturthayoś ca* (VI 2); *pra(thama)*⟨*ḥ*⟩*(pa)ṃ*⟨*camayor miśraṃ*⟩ (VI 2, the restoration is certain); *sārdhaṃdinena* (IX 2); *paṃcamījātīkaraṇaṃ* (II 10); *sarvemiśrāpi* (V 3) = *sarvamiśram api*; *sāṣṭabhāgadinātrīṇi* (IX 2); *sārdhacatvāriyu*⟨*tā*⟩ (IV 7). Cf. the lengthening of final vowels in Sec. 4.1.3 above.

4.2.5 Declension

A-stem

- *Nom. sg. -a* as in Ap. (Pischel 364 and HGA 80), BHSG 8.22–23, and LM 160. Out of a number of instances, we cite a few: *pratyaya trairāśikena* (I 3, et passim); *ccheda projjhyaṃ* (III 4); *dvitīya paṃcaviṃśayojanā dine yāti* (III 7, 'Another person goes twenty five *yojanas* a day'); *ādyor viśeṣa dviguṇaṃ* (III 8); *tatraiko śva kim udbhavet* (III 16); *anena sarva guṇitaṃ* (IV 9); *anena guṇita jātaṃ* (III 12); *uttara dvayaṃ* (III 14); *niyata puna dviguṇaṃ* (III 15); *yal labdha dviguṇaṃ* (VIII 4); *na ca śeṣa pradṛśyate* (III 28).

- *Nom. sg. m. -aṃ* as in BHSG 8.26. *dīnārako nāma ... duḫkhārjanīyaṃ sukhabhojanaṃ* (X 7); *guṇabhyāso rūpahīnaṃ* (VI 4); *dvitīyaṃ paṃcadivase rasam ārjayate* (VIII 4, 'Another person earns six every five days'); *sa rathaṃ prayāsyāt* (X 15); *kaś ca lābhaṃ* (VIII 8); *kaḫ kālaṃ* (IX 1, 3).

- *Nom. sg. -ā* as in Ap. (Pischel 364 and HGA 80) and BHSG 8.24. *eṣāṃ cchedāṃ* (= *chedaḥ*) *kṛtā* (X 24); *aiko śva rūḍhā* (III 16) = *eko 'śvo rūḍhaḥ*; *daśāṃśā kṣīyate s=trayaṃ* (III 20); *eśa sarvatra kartavyā* (III 22); *ko rāśi paṃcayutā mūladaḥ* (VIII 2); *brahma(lo)⟨ka⟩(pa)rīmuktā... paṭaṃ* (X 10); *jātā phalaṃ* (IV 3); *prathamā tṛtīyasya tṛguṇaṃ* (IV 9, 'Three times ⟨the property of⟩ the first is of the third'); *kim atra prathamasya dattāsīt* (IV 8, 'What was, in this case, given to the first?'); *pṛṣṭhā śatadvayaṃ* (V 5); *padaṃ sthāpitavyā* (III 8); *phalaṃ mūlā 500* (III 22); *mūlā caturviṃśatiḥ* (VIII 7); *etāvad api rūpasaṃśuddhā* (III 27); *utpaṇṇā śataṃ śaṣṭivimiśṛtaṃ* (VIII 8); *guṇākāradvayā* (I 10).

- *Nom. sg. n. -āḥ.* *padaṃ hīṇāḥ* (III 8). This instance is probably to be included in the nom. sg. *-ā* above. For the *visarga*, see Sec. 4.1.4 above.

- *Nom. sg. -āṃ.* Cf. the acc. sg. *-āṃ* in BHSG 8.38. *rāśeko ṣṭatāṃ vākṛtāṃ r=harai* (X 11) = *rāśyeko 'ṣṭatāṃ vyākṛto haraiḥ*; *eṣāṃ cchedāṃ kṛtā* (X 24) = *eṣāṃ chedaḥ kṛtaḥ*; *aparāṃ udā* (X 26) = *aparam udāharaṇaṃ*; *jātā 14 / 18 / 28 / ekāṃ 60* (V 1, 'Produced are 14, 18, and 28; the sum is 60').

- *Nom. sg. -u* as in Ap. (Pischel 346, 351, and 363, and HGA 80), BHSG 8.20, and LM 155. 35 *ghaṭike* (inst. sg.) *dinu* (I 18); *padu, dhanu* (VII 8, in an enclosure); *madhuprastu 1* (III 23) = *madhuprasthaḥ 1*; *aṃbhabhāgā prastu 2* (III 23) = *ambhobhāgaḥ prasthau 2*. This last example uses the sg. ending for dual.

- *Nom. sg. m. -o* as in Pkt. (Pischel 363 and Geiger 78), Ap. (HGA 80), BHSG 8.18–19, and LM 159. *śarpo ṣṭādaśahasto praviśaty* (X 6); *dhanā* (abl.) *sva=m=ardho saṃśoddhya* (nom.) (II 9); *tatseṣā* (= *taccheṣāt*) *paṃcamo bhāgo te* (II 9); *catusaṣṭhibhi bhaveṭ tallo /* (V 6); *dvayo ca* (III 8); *dvayo keci* (VIII 5); *⟨e⟩ko prāpto* (III 35).

- *Acc. sg. -a* as in Ap. (Pischel 364 and HGA 80), BHSG 8.31–34, and LM 167. *dvaya 2 adhe dāpaye* (X 17); *trayena uparimarāśīdvaya guṇaye* (X 17); *labdha kṣepaṃ vinirdiśet* (V 1); *kṛtvā rūpakṣayaṃ pārtha* (= *prāstaṃ*) (III 19); *palatṛbhāgaṃ kṣaya vrajati* (III 21); *tṛbhāgaṃ kṣaya gacchati* (III 21); *dvābhyāṃ eka paṃcabhi dvayaṃ saṃguṇya* (III 35); *rūpoṇe* (inst. or loc.) *mūla guṇaye* (VIII 7).

- *Acc. sg. -aḥ.* *kaścit pumāṃ suvarṇas tu ... dattavān* (X 13); *icchā⟨ṃ⟩(ka)⟨ḫ⟩ pra(tha)⟨me nyasya⟩* (VI 2, the restoration of '*ḫ*' is certain, as the '*pra*' is written unusually below the

mātṛkā line); *(pari)⟨vartana⟩ḥ kṛtvā* (IV 1, the restoration is confirmed by a parallel passage in IV 2); *tato me cchindhi saṃśayaḥ* (III 5); *gantavyaḥ ā⟨kramya⟩* (III 18). Some of these examples may be included in the acc. sg. *-a* above. For the *visarga* and its equivalents, see Sec. 4.1.4 above. Cf. also the nom. sg. n. *-āḥ* above.

- *Acc. sg. -ā* as in Ap. (HGA 80) and BHSG 8.38. *prathamā caturguṇaṃ caiva caturthe* (loc. for dat.) *caiva dattavān* (IV 4, 'He has given four times the first to the fourth'); *samadhanā prati* (VIII 4).
- *Acc. sg. -u* as in Ap. (Pischel 363 and HGA 80), BHSG 8.30, and LM 165. *jātu saṃguṇya* (III 27, sg. ending for dual; 'Having multiplied the products ⟨by each other⟩').
- *Acc. sg. -o* as in Ap. (HGA 80), BHSG 8.36, and LM 166. *kṣepasaṃjñako datvā* (III 9, 10, 12); *vṛddhidvayo gataṃ* (III 26); *maśako vadaḥ* (III 35) = *māṣakaṃ vada.*
- *Inst. sg. -ana or -āna.* *yavanāsti* (X 2) = *yavenāsti*; *pādanāsti* (X 2) = *pādenāsti.* Cf. the inst. sg. *-āna* or *-ānā* for *ā*-stem nouns below. Analogy of the inst. sg. *-inā* of *i*-stem nouns?
- *Inst. sg. -e* as in Ap. (HGA 81) and LM 170. Cf. inst. pl. *-e* in Pali (Geiger 79.6). Tagare (HGA, p. 117) states: 'In the South and the West *-e* is probably a scribal error as such forms are comparatively rare in SWAp. literature.' But see Grierson's remark (LM, p. 96, fn. 3): 'In Ṭākkī Prakrit, which was spoken in the northern Panjab, just south of Kashmīr, the Inst. Sing. optionally ended in *-ē*.' There are nearly thirty instances of this ending in the BM. To cite a few: *sītā... gaganaṃ nīta rāvaṇe* (X 9, Śloka; 'Sītā... was taken to the sky by Rāvaṇa'); *kiṃ tatra prathame prāptaṃ kiṃ prāptaṃ apare jane* (II 7, Śloka); *upare uparaṃ guṇitavyaṃ* (VII 3); *adhe uparaṃ guṇaye* (I 10); *prathame dvitīyasya ssapta dattā* (VIII 5); *kena mānake* (VIII 9, Śloka); *dramme trapusaśataṃ r=labdhaṃ ardhena labhyate ḫ=kati* (X 26, a hyper-metric Śloka); *sārdhadvaye traya sārdhadivardhe labhyate ḫ=kati* (X 26, Śloka); *trairāśike mūlyaṃ kartavyaṃ* (V 6).
- *Inst. sg. -aina.* *tac cottaraiṇa* (III 9). Cf. *e* > *ai* in Sec. 4.1.1.
- *Abl. sg. -a* as in BHSG 8.9 (cf. the gen. sg. *-a* in HGA 83). *śeṣa catvāra kuḍavaḥ* (III 24, 'From the remainder, four *kuḍavas* are ⟨drunk⟩').
- *Abl. sg. -ā* as in Pkt. (Pischel 363 and Geiger 78), Ap. (HGA 83B), BHSG 8.46–48, and LM 176. *kasmāt kāraṇā* (II 2); *śeṣā cakuḍavā pītā* (III 24, 'From the remainder, four *kuḍavas* are drunk'); *dhanā sva=m=ardho saṃśoddhya* (II 9, 'From a ⟨certain⟩ quantity, its own half should be subtracted'); *tṛtīyāyaṃ śoddhya* (VI 2, 'This should be subtracted from the third') = *tṛtīyād ayaṃ śodhyaḥ; eṣadhanā dṛṣyā śodhanīyā* (II 8) = *etaddhanāni dṛśyāc chodhanīyāni*; *puna tṛbhāgā divardhaṃ tadā catu⟨rbh⟩iḥ kim iti* (III 21); *akṛte śliṣṭakṛtyūnā* (VII 6) = *akṛteḥ śliṣṭakṛtyūnāt* (for *-ūnāyāḥ*); *suvarṇakanakābhyastā* (III 36); *tatseṣā* (= *tacchesāt*) *paṃcamo bhāgo* (II 9); *śaḍbhi 24 // svarā* (= *svārdhāt*) *12 // ardhā* (= *ardhāt*) *18 //* (X 25).
- *Abl. sg. -ātaḥ* as in BHSG 8.50–52. *guṇātaḥ* (III 23) = *guṇāt.* A false Skt. form from d. *guṇāo* or *guṇādo* or *guṇāto.* Cf. Pischel 363 and Geiger 72.2.
- *Loc. sg. -a* as in BHSG 8.11 and LM 186. *tayor yoga viyo⟨gaṃ syāt⟩* (II 1); *tayor yoga viyogaṃ syā viyoga sa⟨t⟩i ⟨saṃgamaḥ⟩* (II 2). This stanza is cited from an unknown source.
- *Voc. sg. m. -ā* as in Pkt. (Pischel 71 & 366[b] and Geiger 79.3), Ap. (HGA 80), and BHSG 8.27. *gaṇakottamā* (X 10, 15).

- *Gen. du. -ayo* (loss of final *s*). *pravṛttiśeṣaṃyo piṇḍaṃ* (III 28, the *anusvāra* of '*śeṣaṃ*' is probably a graphic error).
- *Nom. pl. -a* as in Ap. (Pischel 363–364 and HGA 84), BHSG 8.79 & 101, and LM 191–192. *nṛpatissevya santi vaiḥ* (VIII 5, m.c.); *(suva)rṇa projjhitā ime* (III 33); *⟨sapta⟩tir manuṣya aya* (X 19); *aṣṭau āṇīta kuṃkumāṃ* (nom. pl.) (III 24, m.c.); *ekena labdha catvāri* (X 24, m.c.); *aṣṭhādaśapala krītā* (III 21). Nouns with numerical figures often remain in their bare stems: *puruṣa 15* (II 2, '15 men'); *phalaṃ bhāra 933705* (X 21, 'The result is 933705 *bhāras*'); etc.
- *Nom. pl. -aṃ*. *catvāra kuḍavā bhuktaṃ* (III 24); *kāṃcanāni tatojjhitaṃ* (= *tata ujjhitāni*) (III 35); *ṣṣaṭ vikṝtaṃ* (VIII 9, a collective sg.?).
- *Nom. pl. -aḥ* as in BHSG 8.83. *śeṣa catvāra kuḍavaḥ* (III 24) = *śeṣāc catvāraḥ kuḍavāḥ*; *dinagamanayojanaḥ paṃca* (III 10); *āhur akṣāhanī budhaḥ* (X 23) = *āhur akṣauhiṇīṃ budhāḥ* (*Mahābhārata* 1.2.18d).
- *Nom. pl. -ā* as in Pkt. (Pischel 363 and Geiger 78), Ap. (HGA 84), BHSG 8.78 & 100, and LM 193. *ete samadhanā jātā //* (VIII 5); *ete vrīhakā sarvattraḥ* (I 3); *suvarṇā... rahitā samabhāgatāṃ* (nom. pl.) (III 32); *ekatrāvartitā kilaḥ* (III 36, '*suvarṇāḥ*' understood); *yady ekasya traya satrayaaṣṭhabhāgā tadā* (III 20); *trayaś ca katibhiḥ prāptā ṣaḍ* (III 35); *śeṣāḥ puruṣabhājitā* (II 2, 5, 8); *śeṣā* (abl.) *cakuḍavā pītā* (III 24); *ssapta dattā* (VIII 5); *paṃca tṛguṇitā sakhe* (X 11); *jātā mūladhanāni* (VI 4); *yady ekasya ṣaṭ yojanā tadā* (III 18); *aṣṭhādaśapala krītā kiṃ kṣayaṃ* (III 21). Words with numerical figures often take this ending: *vaṇijakā 3* (III 5); *hayā 10* (III 16); *śarā 2624400* (X 22); etc.
- *Nom. pl. -āṃ* as in BHSG 8.85 & 102. *aṣṭau āṇīta kuṃkumāṃ* (III 24); *suvarṇā... samabhāgatāṃ* (III 32); *trayaś ca ... prāptā suvarṇāṃ* (III 35).
- *Nom. pl. -e* as in Ap. (HGA 84), BHSG 8.80 & 103, and LM 193. Cf. the acc. pl. *-e* in Pkt. (Pischel 363 and Geiger 78), and nom. sg. *-e* in Pali (Geiger 80). The words with this ending in the BM are always followed by numerical figures: *pha māśe* $\genfrac{}{}{0pt}{}{12}{1}$ (III 33, 'The result is 12 *māṣas*'); *maḍe 6* (VII 11); *maṃḍe 20, sūḍhe 13* (VII 12).
- *Nom. pl. -o* as in BHSG 8.83. *jalakuḍavo* $\genfrac{}{}{0pt}{}{10}{1}$ (III 24).
- *Acc. pl. -a* as in Ap. (Pischel 363–364 and HGA 84), BHSG 8.94 & 101, and LM 196. *ādi paṃca uttaraṃ trīṇi naro yojana gamyate* (III 11); *prathamena* (inst. for nom.) *dvitīyasya* (gen. for dat.) *daśadīnāra dattavān* (VIII 5).
- *Acc. pl. -aṃ*. *kṣayaṃ saṃguṇya kanakās* (inst. pl.) (III 32); *kṣayaṃ saṃguṇya kanakā* (inst. pl.) (III 32 and 33); *suvarṇaṃ te ca sammiśrya* (III 34).
- *Acc. pl. -ā* as in Ap. (Pischel 363 and HGA 84), BHSG 8.92 & 100, and LM 196. *uttarā bhājya* (error for *bhājyato*) *hitvā* (II 8); *aṣṭhādaśayojanā ekena* (inst. for nom.) *dine yāti ... dvitīya paṃcaviṃśayojanā dine yāti* (III 7); *hrarā* (= *harān*) *hareṣu guṇayet* (VII 4); *aṃśair aṃśā guṇayet* (VII 9); *ūnais saṃguṇya kanakā* (III 36); *brāhmaṇā bhojane dadyā paralokahitārthinaḥ* (IX 2).
- *Acc. pl. -āṃ* (*ṃ* for *n*) as in BHSG 8.90 & 102. *uttarāṃ bhājya* (error for *bhājyato*) *hitvā* (II 1); *aṃśāṃ viśoddhya* (III 1, 4).
- *Inst. pl. -a*. Cf. the inst. sg. *-a* in BHSG 8.8. *tṛśataṃ yojanānāṃ tu saptayojana hīyate* (X 10, m.c. from -ā?, 'Three hundred *yojanas* are decreased by seven *yojanas*'). See the inst. pl. *-ā* below.

- *Inst. pl. -aḥ.* A graphic error? *sarva* (acc.) *ṣṣaḍbhi paṇar guṇaye* (I 12); *paṃcābdai māsam evaṃ tu dinai paṃcadaśas* (as an *a*-stem) *tathāḥ* (X 13); ⟨*s*⟩*mṛtā ti*⟨*s*⟩*ra*⟨*s tu vāhinyaḥ pṛtaneti*⟩ *vicakṣaṇaḥ* (X 23, cited from *Mahābhārata* 1.2.17cd).
- *Inst. pl. -abhiḥ* as in BHSG 8.113. Cf. the inst. pl. *-ahiṃ* in Ap. (Pischel 363 & 368 and HGA 85). *kiṃ śeṣaṃ dattabhir bhavet* (III 25, m.c.).
- *Inst. pl. -ā.* Cf. the inst. sg. *-ā* in Pali (Geiger 78). *kṣayaṃ saṃguṇya kanakā* (III 32, 33).
- *Inst. pl. -āḥ.* *kṣayaṃ saṃguṇya kanakās* (III 32); *yadi śeṣam ekaṃ tṛbhi tryaṣṭhabhāgasaṃyutais tu labdhaṃ tadāṣṭhottaraśatāḥ kiṃ* (III 20).
- *Inst. pl. -ai* (loss of final *s*). This ending is said to occur often in Lefmann's edition of the *Lalitavistara*, but is doubted by Edgerton (BHSG 8.107). More than thirty examples are found in the BM. To cite a few: *aśvai hayai ūṣṭhrībhyaḥ* (III 5); *varṣai tṛbhis tu* (III 25); *dvātriṃśabhi maṇḍalakai ṭallikā* (V 6); *kai dinai bhūtale prāpya* (X 10); *ekādaśai bhuktā* (X 13); *drammai aṣṭhabhi* (X 18); *triṃśabhir dinai jīvalokā* (X 19).
- *Abl. pl. -ebhya* (loss of final *s*) as in BHSG 8.116. *aṃśāṃ* (acc. pl.) *viśoddhya cchedebhya* (III 1).

Ā-stems

The feminine nouns *ghaṭikā* and *śālā* sometimes take the masculine endings: *ghaṭike* (I 18, inst. sg.); *ghaṭikaiḥ* (X 15, inst. pl. in form, but inst. sg. in sense); *śulkaśālais* (III 24); *pratyaikaśāleṣu* (II 6). Cf. HGA 88 and BHSG 9.103 respectively for the inst. sg. *-e* and the inst. pl. *-ai(s)* used for feminine stems in *-ā*. Other irregularities noticed in the endings for feminine *ā*-stem nouns are as follows.

- *Nom. sg. -a* as in Ap. (Pischel 100 and HGA 88), BHSG 9.8–9, and LM 162. *sītā... gaganaṃ nīta rāvaṇe* (X 9, m.c.); $\frac{1}{60}$ *viliptā lipta* (X 16); *saptati śodhya* (III 18).
- *Nom. sg. -aṃ.* Cf. the acc. sg. *-aṃ* in HGA 88 and the nom. sg. *-u* in BHSG 9.13. ⟨*ataḥ pā*⟩*tyaṃ śaṣṭhiḥ* (III 3).
- *Nom. sg. -aḥ.* Cf. the nom. sg. *-u* in BHSG 9.13. *sītā candranibhbāṇanaḥ* (X 9); *dalitā...* ⟨*ā*⟩*diyutaḥ* (VII 8).
- *Nom. sg. -āṃ* as in BHSG 9.11–12. *kena kālena gatisāmyatāṃ* (III 7); *kena kālena samatāṃ* (III 11, 14, VIII 5); *kena kālena sāmyatāṃ* (III 15); *na jñāyate t=pravṛttikāṃ* (III 28); *kāṃ pravṛttī syā* (III 28) = *kā pravṛttiḥ syāt*; *uttare ekahīnatāṃ* (III 34); *yaś śeṣaṃ lābhapiṇḍatāṃ* (VIII 8); *caturaśītir ucchṛtāṃ* (X 8); *eṣāṃ caikāṃ rāśi punar ... nītā* (X 11).
- *Nom. sg. -āni.* Cf. the nom. pl. *-āni* below. *saptānāṃ m=api caikā rāśis tulitāni* (X 11).
- *Acc. sg. -ā* as in Ap. (HGA 89), the Pallava grant (Pischel 374), and BHSG 9.20–22. *bhukte* (3rd sg.) *rāśaikā* (= *rāśyekāṃ*) *yadi bhānujaḥ* (X 16); *ekarāśistukalanā gaṇitaprakṛyā kuruḥ* (X 26, '*rāśistu*' is probably a graphic error for *rāśika*).
- *Inst. sg. -āna or -ānā.* Cf. the inst. sg. *-ana* and *-anā* of *a*-stems above. *kalānāsti* (X 2) = *kalayāsti*.

- *Gen. sg. -ā* as in BHSG 9.67 and LM 181. *divardhamāśakasya divardha=m=āṇḍikā divardha-yavasya kiṃ mūlyaṃ* (X 4).
- *Nom. pl. -ā* as in Pkt. (Pischel 374 and Geiger 81), Ap. (HGA 93), BHSG 9.82–85, and LM 194. *maṇḍakā 20* (VII 11); *a⟨kṣauhi⟩nyā catasrā vai hatā tena mahātmavāṃ* (X 22).
- *Nom. pl. -āni* as in BHSG 9.98. Cf. the nom. sg. *-āni* above. *tatas tisra samādāya tulitāni trayandaśa* (I 1). Cf. Tagare's remark: 'In WAp. (= West Ap.) we find that the terminal of the Neut. direct plur. is applicable to Fem.'
- *Inst. pl. -ābhiṃ.* Cf. the inst. pl. *-āhiṃ* in Pkt. (Pischel 374) and Ap. (HGA 93). *maṇaleābhiṃ* (V 6) = *maṇḍalikābhiḥ.*

I-stems

As in BHSG 10.9–11 and LM 19, confusion between *i-* and *ī-* stems is noticed in the BM. Thus, the word *karaṇī* occurs twice with a final short *i* (VII 9, 10); the non Skt. word *kaṭi* (= *kṛti*?), meaning mixture or alloy, also assumes the form *kaṭī* (both forms in III 35).

- *Nom. sg. -i* as in Pkt. (Pischel 377 & 379 and Geiger 82), Ap. (HGA 94), and BHSG 10.15–16. This occurs very often in the BM. To cite a few instances: *kṣepasaṃjñako rāśi* (III 9); *eko rāśi dvidhā sthāpya* (VII 7); *aparo vidhi kryate* (X 5); *kā vṛddhi vyāptā* (X 26); *kā pravṛtti bhavet sakhe* (III 30); *tatroktā maṇi vikrītā* (III 1); *karaṇi pātita* (VII 9).
- *Nom. sg. -iṃ* as in Pkt. (Pischel 377 & 379 and Geiger 85) and BHSG 10.23–24. *tatra gatiṃ* (I 17); *eṣāṃ yutiṃ kryate* (III 4); *hīne yutiṃ ca kartavyā* (VIII 2); *bhuktā prasṛtiṃ* (X 13); *eṣa grahagatiṃ* (X 16). The same ending occurs also in a note by the scribe: *sūtre bhrāntim asti* (III 8).
- *Nom. sg. -ī* as in Pkt. (Pischel 377 & 379) and BHSG 10.26–28. *kāṃ pravṛttī syā* (III 28) = *kā pravṛttiḥ syāt.*
- *Acc. sg. -i* as in Pkt. (Pischel 377 and Geiger 85 for neuter), Ap. (HGA 94), and BHSG 10.47–50. *paṃcaśaṣṭhi nṛpo dadau sevakānāṃ dīnārān* (I 2); *gadyūti gadyūti gatvā* (III 23); *kaṭi dṛṣṭhvā* (III 35); *caturtharāśi guṇaye* (IV 7); *prakṣepayukti saṃsthāpya* (V 2).
- *Abl. sg. ī* as in BHSG 10.65–67 and LM 177. *ādimarāśī paṃca śoddhyaṃ* (VI 1).
- *Abl. sg. -e* (loss of final *s*). Cf. the gen. sg. *-e* in BHSG 10.72. *akṛte śliṣṭakṛtyūnā* (VII 6).
- *Gen. sg. -aï.* Cf. the gen. sg. *-ayi* in BHSG 10.140. *vajramaṇaï* (X 14) = *vajramaṇeḥ.*
- *Gen. sg. -isya* as in BHSG 10.78–79. *gatisyaiva viśeṣaṃ* (I 17, III 6, 7). A false Skt. form from d. *-issa.* Cf. the gen. sg. *-issa* in Pkt. (Pischel 377 and Geiger 82).
- *Gen. sg. -e* (loss of final *s*) as in BHSG 10.72. *saptate dviguṇāyāś ca* (III 20).
- *Nom. pl. -ī* as in Pkt. (Pischel 377 and Geiger 82 & 85), Ap. (HGA 96), BHSG 10.177–179, and LM 195. *ebhir dinai samagatī bhavanti* (III 7); *evaṃ riṇarāśī bhavanti* (IV 11).

Ī-stems

- *Acc. sg. -i* with the lengthening of the penultimate. *anīkīni daśaguṇām āhur akṣāhanī budhaḥ* (X 23) = *anīkinīṃ daśaguṇām āhur akṣauhiṇīṃ budhāḥ* (Mahābhārata 1.2.18cd). This ending, if it is not a graphic error, may have been influenced by the nom. & acc. pl. *-īni* in Pkt. (Pischel 377 & 381 and Geiger 85 for neuter) and in BHSG 10.160 (for masculine and feminine).

- *Acc. sg. -ī* (loss of final *m*) as in Ap. (HGA 97), BHSG 10.55, and LM 195. *yajaṃti devī prati=m=ahni* (X 2); *āhur akṣāhanī budhaḥ* (X 23) = *āhur akṣauhiṇīṃ budhāḥ*.

- *Gen. sg. -yā* (loss of final *s*) as in Pali (Geiger 86.2) and BHSG 10.123. *kacit dadāmi devyā ca* (X 2, gen. for dat.).

- *Nom. pl. -ī.* as in Pkt. (Pischel 377 & 384 and Geiger 86), Ap. (HGA 97), BHSG 10.186, and LM 195. *eṣagavāśvamahiṣī pratyaikaśāleṣu bhava⟨nt⟩i* (II 6).

- *Nom. pl. -yā* as in BHSG 10.164. *a⟨kṣauhi⟩nyā catasrā vai* (X 22).

- *Inst. pl. -ībhyaḥ* (confusion of the oblique cases). Cf. the abl. pl. *-bhi* for *n*-stem nouns below. *aśvai hayai ūṣṭhrībhyaḥ* (III 5).

U-stems

- *Nom. sg. m. -u* as in Pali (Geiger 82), Ap. (HGA 96), and BHSG 12.8–10 & 12.13. Cf. the nom. sg. n. *-u* in Pkt. (Pischel 378) as well as in Skt. *sumeru pṛthivīśaṃku parimāśrayaṃ* (X 8).

- *Gen. sg. -unā?* *madhunā s=tathā* (III 23). This ending, if it is not the regular inst. sg. , may have originated, in one way or another, from d. *-uṇo* (< Skt. *-unas*). Cf. Pischel 378–379 and Geiger 82.

- *Gen. sg. -va?* *eśa maddhva bhāgā* (III 23). This ending, if it is not a graphic error for '*u*' (a possible corruption in Śāradā), may have originated from the regular feminine ending *-vāḥ*.

Ū-stems

- *Nom. pl. -ūḥ* as in BHSG 12.56. Cf. the nom. pl. *-ū* in Pkt. (Pischel 387 and Geiger 86) and in Ap. (HGA 97). *tisraś camū⟨s⟩ tu ⟨nīkinī⟩* (X 23).

Diphthongal Stems

- *Nom. sg. f. nau* (loss of final *s*). *yā nau dina . . . gacchati* (X 12).

- *Nom. sg. f. gāvī* (VIII 3) = *gauḥ*. This form occurs in AMg. and JM. (Pischel 393) and in Pali (Geiger 88.3). Cf. *yuvī* (VII 12) = *yuvati* or *yuvatī*.

Consonantal Stems

T-stems

- *Voc. sg. -ān (or -āṃ)* as in BHSG 18.81. *ślisṭhamūlaṃ ānayasva matimā⟨n it⟩(i)* (III 12); *mahātmavāṃ* (X 22).

N-stems

- *Nom. sg. adhvānaṃ* (III 11) = *adhvā*. Cf. Pischel 402, who cites Pkt. *addhāṇo*, and BHSG 17.37–38, which cites *adhvāna-*.
- *Nom. sg. paṃthā* (III 8, loss of final *s*).
- *Nom. & acc. sg. karmaṃ* as in BHSG 17.10. Declined as an *a*-stem nouns. Cf. the same phenomenon in Pali (Geiger 94).
- *Loc. sg. carmāṇi* (X 7) as in BHSG 43.
- *Inst. pl. -abhi* (loss of final *s*). *dvijanmabhi* (III 17).
- *Abl. pl. -abhi* (misuse of the inst. pl. *-abhiḥ* with the loss of final *s*). Cf. the inst. pl. *-ībhyaḥ* for *ī*-stem nouns above. *eta caturdaśabhi śoddhya* (VI 1, 'This is to be subtracted from fourteen').

S-stems

As in Pkt. (Pischel 407 and Geiger 99–100) and BHSG 16.1, nouns in *-as* show, besides the regular *-as*, two types of irregular stems, *-a* and *-asa*.

- *In comp., -a* as in BHSG 16.10. *aṃbhabhāgā* (III 23); *ahadravya* (VIII 4, 5).
- *Nom. sg. -asaṃ* as in BHSG 16.6. *payasaṃ* (V 2).
- *Inst. pl. -bhi* (loss of final *s*). *trayāhobhi* (X 12).

4.3 Pronouns

4.3.1 Stem tad

- *In comp., ta & te* as in BHSG 21.2. *tasāyakaiś* (X 22); *terdha* (X 7) = *tadardha*.
- *Nom. sg. m. ta* as in Ap. (HGA 123). *māśakārdhayuto dhya[rdha]ku⟨ḍa⟩(va)s ta paṃcapaṃcā-śasatereṇa* (X 14, '*ta*' refers to *kuḍava*).
- *Nom. sg. m. so* as in Ap. (HGA 123), Pali (Geiger 105), and BHSG 21.5. *ko so rāśir* (VIII 2).
- *Nom. sg. m. & n. sā.* *ko rāśi paṃcayutā ⟨m⟩ūla⟨da⟩ḥ sā rāśis* (VIII 2); *yal labdhaṃ sā bhavet kālaṃ* (VIII 3); *yal labdhaṃ sā bhaven mū⟨laṃ⟩* (VIII 8).
- *Nom. sg. n. ta* as in Ap. (HGA 123). *ta dviguṇaṃ* (IV 4); *yac cheṣaṃ ta dviguṇa* (I 7).
- *Nom. & acc. sg. te* as in Ap. (HGA 123). Cf. BHSG 21.7 for the nom. sg. m. *te*. *te ⟨ca piṇḍaṃ⟩ śatadvayaṃ / aśītyādhikaṃ dhanaṃ caiva* (II 9, 'That ⟨remainder⟩ plus a sum of two hundred and eighty is exactly ⟨equal to⟩ the ⟨original⟩ quantity'); *tatpunas te samaṃ bhaktvā* (III 17, 'When, however, they have divided that ⟨obtained⟩ equally ⟨among themselves⟩'). These instances may, however, be interpreted as plurals. Cf. the acc. pl. *te* below.

- *Nom. sg. n. sa* as in Ap. (HGA 123). *yad bhave labdha⟨ṃ⟩ sa kṣay⟨ā⟩jñātamāśaka⟨ṃ⟩* (III 35); *vibhaktaṃ sa ca kartavyaṃ* (VIII 8).
- *Acc. sg. m. ṭa* as in Ap. (HGA 123). *vada me ta suniści⟨taṃ⟩* (X 8, '*ta*' refers to *kāla*).
- *Abl. sg. m. or n. tasthāt (VII 2) and tasnāt (VII 6) = tasmāt* (adverbial use). Cf. BHSG 8.57, which cites the word *agārasthā* (= *agārāt*) from *Mahāvastu* i.104.8 (Senart's edition).
- *Gen. sg. f. tasyaṃ. aṣṭādaśī ka⟨lā⟩ / tasyaṃ viṃśatibhāgaś ca* (X 11).
- *Acc. pl. m. or n. te* as in Ap. (HGA 123), Pkt. (Pischel 425), and BHSG 21.30–31. *suvarṇaṃ te ca sammiśrya* (III 34, 'Having mixed up those ⟨pieces of⟩ gold').

4.3.2 Stem etad

- *In comp., eṣa (and eśa). eṣagavāśvamahiṣī* (II 6); *eśadhanā* (II 8); *eṣayutaṃ* (III 2); *eśanyāsa* (IV 10).
- *Nom. sg. m. or n. eta. eta dviguṇaṃ* (II 2); *eta kṣayaṃ* (III 28); *eta caturdaśabhi śoddhya* (VI 1).
- *Nom. sg. m. or f. eṣāṃ. (e)ṣāṃ aparo vidhiḥ* (IV 9). Cf. *aparāṃ udā* (X 26). Cf. the nom. sg. f. *kāṃ* in Sec. 4.3.6 below.
- *Nom. sg. n. eṣa (and eśa). eṣa pādair guṇitaṃ* (III 7); *eṣa rūpādhikaṃ* (III 14); *⟨kā⟩mikaṃ 1 // eṣa ṇyastaṃ* (IV 6); *eṣa deśapramāṇaṃ samāptaṃ* (X 11); *yadi dina=m=ekena eṣa dataṃ* (= *dattaṃ*) *ta* . . . (X 21); etc. This form *eṣa* for n. seems to be related with *ehu* (= *etad*), which occurs in an example written in a dialect (VII 11). See Sec 4.8 below. For Ap. *ehu*, see HGA 124. Cf. Pischel 426 for sg. m. *eṣa* used as n. or f.
- *Loc. sg. etatra. etatra mūlyaṃ vada me* (X 2). Is this a graphic error for *etat* (the second *ta* with *virāma*)? Or from *etad* on the analogy of *tad:tatra*? The meter is uncertain.

4.3.3 Stem idam

- *Gen. sg. sya (= asya). sya pratya⟨yas⟩* (VIII 7); *dvādaśaśata sya bhāṇḍāre sthitā* (IX 3, 'Twelve hundred are in his store'). Cf. BHSG 21.84, which refutes the gen. sg. *sya (= asya)* that occurs in *Mahāvastu* i.278.3 & 5 (Senart's edition).
- *Gen. sg. asya used for dual. asya saṃyoga 111* (II 6, 'The sum of these ⟨two numbers⟩ is 111').
- *Gen. pl. eṣā* (loss of final *m*). *eṣā sadṛśe* (II 5); *e(ṣā) / yuti* (III 32).

4.3.4 Stem adas

- *Nom. sg. m. sau (= asau). kena kālena sau gacche* (X 8, m.c.).

4.3.5 Stem yad

- *Nom. sg. n. ya* (loss of final *d*). *ya śśeṣaṃ* (VIII 8).

4.3.6 Stem kim

- *Nom. sg. m. ka* (loss of final *s*). *ka k⟨r⟩īyate* (V 6).
- *Nom. sg. f. kāṃ* as in *ā*-stem nouns (Sec. 4.2.5) and the stem *etad* (Sec. 4.3.2). *⟨k⟩āṃ pravṛttī syā* (III 28).
- *Inst. sg. kena* in '*gṛhītaṃ kena mānake*' (VIII 9) is probably used for *kena cid*, if it is not a graphic error for *yena*, which would be the correlative of *tasya* that occurs in the last *pāda* of the same stanza.
- *Inst. pl. kai* (loss of final *s*). *kai dinai bhūtale prāpya* (X 10).

4.3.7 Interogative + cid

- *Nom. sg. m. kaści* (loss of final *d*) in III 15, 29, and X 8.
- *Acc. sg. m. kacit* (= *kaṃcid*). *kacit dadāmi devyā ca* (X 2).
- *Nom. pl. m. keci* (loss of final *d*) in VIII 5.

4.3.8 Pronominal Adjectives

- *The word eka* sometimes assumes the form *aika*. *aiko śva rūḍhā* (III 16); *pratyaika* (II 6, III 5, VI 3); *rāśaikā* (X 16) = *rāśyekā*.
- *Abl. sg. ekāt* (= *ekasmāt*). *⟨ya⟩dy ekāt paṃtupaṇyānāṃ* (= *pañca-*) (I 15). Cf. Vedic *tāt* of *tad* (Pischel 425).
- *Gen. sg. m. ekāsya. m=ekāsyāhne dvayaṣṣa⟨ḍ⟩gā* (= *-ṣaṭkā*?) (VIII 5).
- *Nom. pl. sarve in comp. sarvemiśrāpi* (V 3) = *sarvamiśram api.*

4.4 Numerals

4.4.1 Cardinal Numbers

- *1 (eka)* For the irregular form *aika*, see Sec. 4.3.8 above. For the possible form *meka*, see under the *sandhi*-consonants in Sec. 4.1.3.
- *2 (dvi)* For the inst., besides the regular *dvābhyāṃ* (III 35), we have *dvibhis* (VIII 6, 7). Cf. BHSG 19.4, which cites *dvibhis* from the *Mahāvastu*, *Lalitavistara*, and *Saddharmapuṇḍarīka*. In comp., the form *du-* is used once: *dūnā* (I 3) = *dviguṇā*. Cf. *duuṇa* in M. (Pischel 436), *dūṇā* in Ap. (HGA 106), *du-* in LM 209, and *dūnā* in Hindī.

- *3 (tri)* The masculine stem *traya-*, like *a*-stem nouns, takes the long final *ā* for the nom. pl. in X 23. In comp., *tṛ-* is common, though the normal *tri-* also occurs several times. For *ri* > *ṛ*, see Sec. 4.1.2 above. The form *trayan* occurs before other numerals: see *trayandaśa* (13) and *trayantṛṃśa* (33) below. The nom. pl. n. *trīṇi* occurs as a member of comp.: *trīṇiśatasārdhā* (X 19); *sāṣṭabhāgadinātrīṇi* (IX 2). A doubtful form is *tre-* in: *atha trīṇi tresārāda* ... (IV 12, the meaning uncertain). But cf. *tre- (= tri-)* in LM 210 and *te-* in AMg. (Pischel 438) and Ap. (HGA 107).
- *4 (catur)* The feminine stem *catasra-*, like *a*-stem nouns, takes the form *catasrā-* for the nom. pl. in: *a⟨kṣauhi⟩nyā catasrā vai* (X 22). Probably, *catvāra* is used for the acc. in: *(ca)tvāra 4 saṃguṇya* (III 35). The form *canvāri* for *catvāri* occurs once (I 7). The nom. pl. n. *catvāri* is used as a member of comp.: *sārdhacatvāriyu⟨tā⟩* (IV 7). Besides this and the regular *catur-*, we have *catu-* (as in BHSG 19.13) several times, and *cāri-* once: *catusaṣṭhibhi* (V 6); *catuprasthai* (III 23); *catuśulkaśālais tu* (III 24, the meter requires '*caturbhiḥ*'); *catuvargaṃ* (VIII 9); *cāriy⟨u⟩ktaṃ* (I 7). Cf. Ap. *cāri* (= *catvāri*) cited by Pischel 439, who remarks that it is used as a prior member of a comp. For *catu-*, cf. Geiger 115. Cf. also *caü* in Ap. (Pischel 439 and HGA 108). The form *cau* occurs before other numerals: *caupaṃcāśama* (VIII 7). Cf. *caurāśīti* (I 3) = *caturaśīti*. Probably, *ca* = *catur* in: *śeṣā cakuḍavā pītā* (III 24, 'From the remainder, four *kuḍavas* are drunk'). Cf. *cā* (= *catur*) in LM 211.
- *5 (pañca)* A strange form is *paṃtu* in: *paṃtupaṇyānāṃ* (I 15).
- *11 (ekādaśa)* Inst. pl. *ekādaś(ai)* (X 13). Probably, words in *-daśa* are sometimes treated as *a*-stem nouns. So also are the words in *-viṃśa*, *-triṃśa*, etc. Cf. Geiger 117 and BHSG 19.26 & 30–33.
- *12 (dvādaśa)* Nom. *dvādaśan* (V 5).
- *13 (trayodaśa)* *trayandaśa* (I 1). Cf. *trayantṛṃśa* (IX 3).
- *14 (caturdaśa)* As an *a*-stem: *caturdaśas tu koṭṭī⟨nāṃ⟩* (X 10); but *caturdaśabhi* (VI 1, abl. in sense).
- *16 (ṣoḍaśa)* Inst. *śoḍaśai* (X 22).
- *17 (saptadaśa)* On the analogy of *aṣṭādaśa*: *saptādaśa* (VI 2). Cf. *saptāviṃśa* (III 28).
- *18 (aṣṭādaśa)* Besides *aṣṭādaśa* and *aṣṭhādaśa*, there occurs *ṣṭhādaśa* (V 3). For the dropping of the initial *a*, see Sec. 4.1.1.
- *20 (viṃśati)* As an *a*-stem: *viṃśaś ca* (V 3); *viṃśānāṃ di(vasānāṃ)* (X 25). Cf. BHSG 19.30–33.
- *21 (ekaviṃśati)* *ekaviṃśa* (VII 13).
- *22 (dvāviṃśati)* *dvāviṃśa* (IV 8).
- *25 (pañcaviṃśati)* *paṃcaviṃśa* (III 7); *paṃcaviṅśa* (VII 8).
- *26 (ṣaḍviṃśati)* *śaḍviṃśa* (VII 13).
- *27 (saptaviṃśati)* *saptāviṃśa* (III 28). Cf. *saptādaśa* (VI 2).
- *29 (ekonatriṃśat)* *ekonatṛṃśa* (VII 13).
- *30 (triṃśat)* *tṛṅśa* (I 4, VIII 3); but *tṛṅśadbhir* (X 19).

- *32 (dvātriṃśat)* *dvātriṃśa* (V 6); gen. *dvātṛṅśānāṃ* (III 20).
- *33 (trayastriṃśat)* Inst. *trayantṛṃśai* (IX 3).
- *39 (ekonacatvāriṃśat)* *ekonacatvāriṃśa* (II 5).
- *40 (catvāriṃśat)* *catvāriṃśa* (III 27, VII 1); *catvāriṅśa* (VII 2), and *cāliṃśa* (II 9). For this last form, cf. *cālīsa* in JM (Pischel 445) and Ap. (HGA 113).
- *42 (dvācatvāriṃśat)* *dvācatvāliṃśa* (I 3, VII 13); inst. *dvācatvāliṃśabhir* (X 18). Probably, ⟨*dvācatvā*⟩*riṃśataṃ* (VIII 10) is the acc. sg. form, not of *-śata*, but of the regular *-śat*; but cf. *dvātriṃśata* cited in BHSG 19.34.
- *44 (catuścatvāriṃśat)* *catuścatvāliṃśa* (IV 7, VII 13).
- *50 (pañcāśat)* *paṃcāśa* (III 18, X 6).
- *51 (ekapañcāśat)* Gen. *ekapaṃcāśānāṃ* (X 17).
- *53 (tripañcāśat)* *tṛpaṃcāśa* (VII 13).
- *55 (pañcapañcāśat)* *paṃcapaṃcāśa* (X 14).
- *56 (ṣaṭpañcāśat)* *ṣaṭpaṃcāśa* (VIII 9).
- *64 (catuṣṣaṣṭi)* *catusaṣṭhi* (V 6).
- *83 (tryaśīti)* *tṛrāśīti* (VII 13).
- *84 (caturaśīti)* *caturāśīti* (VIII 7, X 8), *caurāśīti* (I 3). Cf. *caürāsīiṃ* in AMg. and *caürāsīi* in JM (Pischel 446); *caurāsī* in Ap. (HGA 108); and *caturāśīti* in BHSG 19.35 and BHSD.
- *90 (navati)* *uvānta* = *upānta* (penultimate) = 90? It occurs in: uvāntaṃ śataṃ (I 4) = 190.
- *10^5 (lakṣa or niyuta)* See Sec. 6.3 below. *niyata* (X 10) is probably a graphic error for *niyuta*.
- *10^7 (koṭi)* See Sec. 6.3 below. *koṭṭi* (X 10).

4.4.2 Ordinal Numbers

For the first ten ordinals, the normal forms are used: *prathama, dvitīya,* etc. In several places, the suffix *-ka* is used to make ordinals: *catuḥpaṃcakamiśraṃ* (VI 2, 'The sum of the fourth and fifth ⟨terms⟩'); *tṛcatuḥpaṃcakākṣayai* (III 28, 'The loss being one third, one fourth, and one fifth'); *dvisaptaka-* (III 31). For the rest, the ordinals are formed, as in Pkt. (Pischel 449 and Geiger 119), Ap. (HGA 117), and BHSG 19.36, by adding '*ma*' to the cardinals: *ekādaśama* (III 7), *caturdaśama* (III 6), *paṃcadaśama* (III 7), *ṣoḍaśama* (III 8), *aṣṭhādaśama* (III 9, but the regular feminine form *aṣṭādaśī* in X 11), *ekonaviṃśatima* (III 13, VIII 3), *paṃcaviṃśatima* (III 29), *ṣaḍviṃśatima* (III 32), *aṣṭhāviṃśatima* (III 36), *paṃcāśama* (VIII 2), *ekapaṃcāśama* (VIII 3), *dvā-* (VIII 4), *tṛ-* (VIII 6), *cau-* (VIII 7), *paṁca-* (VIII 8), *ṣaṭ-* (VIII 9), and *sapta-* (VIII 10).

4.4.3 Fractions

'One and a half' is often expressed by the word *divardha* (I 14, etc.), which is a pseudo Skt. form from d. *divaḍḍha*, a word that occurs in Pkt. (Pischel 450). Cf. Ap. *diyaḍḍha* (HGA 116, which equates it to *dvyardha*). The regular *adhyardha* (with the reduplication of the first '*dh*') also occurs (III 6, 21).

4.5 Indeclinables

4.5.1 Dropping of Final Consonants

This phenomenon occurs extensively in the indeclinables used in the BM. Cf. BHSG 2.91, which cites, among other examples, *puna, punānyaṃ* (=*punar anyaṃ*), *yāva, paśca*, and *kasyaci* from the *Mahāvastu*, and *tāva, kaści, keci*, and *puna* from the *Saddharmapuṇḍarīka*.

- *adha* = *adhas*. *adhaccheda* (V 6, etc.). For other examples, see Sec. 4.5.3 below.
- *idānī* (III 32) = *idānīm*.
- *ci* = *cid*. *kaści* (III 15, 29, X 8); *keci* (VIII 5).
- *ta* (III 7, etc.) = *tad*. See Index.
- *tata* = *tatas*. *tata projjhya* (III 1); *tatojjhitaṃ* (III 26, 35); *tata* (V 2, at the end of a line of verse).
- *tatvata* (X 13, at the end of a line of verse) = *tattvatas*.
- *tāva* = *tāvat*. *ādau tāva* (I 10, X 19). Cf. Ap. *tāva* (HGA 152A).
- *paśca* = *paścāt*. *paśca śṛṣṭhi* (X 27).
- *puna* = *punar*. *punānyaṃ* (I 9, III 25, X 4) = *punar anyaṃ*; *punāsyaiva* (III 26) = *punar asyaiva*; *puna prathama* (III 2); etc. See Index.

4.5.2 Change of Final i to a

- *upara* = *upari*. See Sec. 4.5.3 below.

4.5.3 Indeclinables Treated as Declinables

The words *adha* (= *adhas*) and *upara* (= *upari*), which are often used to denote respectively the lower and the upper terms of a fraction, are inflected as *a*-stem nouns. Thus, *adhe uparaṃ guṇaye* (I 10, 'One should multiply the upper by the lower'); *adheṇa ūrdhaṃ* (= *ūrdhvaṃ*) *guṇaye* (X 26); *adhenopari saṃguṇya* (X 17, 26); *upare uparaṃ adhe adhaṃ guṇaye* (IV 7, 'One should multiply the upper by the upper, and the lower by the lower'); *adhe adhaṃ upare uparaṃ guṇitavyaṃ* (VII 3); *eṣa uparā pātya* (VII 2, 'This is to be subtracted from the upper'); *jātā uparā* (VII 10, 'The upper is produced ⟨anew⟩'); *uparāḥ* (nom.), in VII 8, is probably *uparā* + terminal sound *ḥ* (see Sec. 4.1.4 above).

The word *ekat(t)ra* is also treated as an *a*-stem noun meaning 'total' or 'sum'. In comp.: *ekatra-guṇitaṃ* (IV 10). Nom. sg.: *ekat(t)raṃ* (I 1, 4, 5, II 7, IV 8, 9, X 25). Loc. sg.: *ekattre* (I 4). The word *ekatva* is also used in the same sense (see Index). Are these words false Skt. from d. *ekacca*? Cf. Pali *ekacca* (Geiger 113.9).

The transition of indeclinables to *a*-stem nouns in Pkt. has been noticed by Pischel 342 & 345.

4.5.4 Other Peculiarities

- *-to* = *-tas*. *ato* (I 17, et passim); *tato* (III 2); *vastrato* (VIII 10). Cf. *to, atto*, and *tatto* in Pkt. (Pischel 142 & 197).
- *p⟨r̥⟩thaṃ* (I 12) = *pr̥thak*. For *-ak* > *-aṃ*, cf. Pali *tiriyaṃ* = *tiryak*. This is probably another example for Sec. 4.5.3 above, but the reading is not very certain.

4.6 Verbs

I. F. R.
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4.6.1 Person

There is nothing special to report about person in the language of the BM.

4.6.2 Number

Confusion in number is to be noticed several times in the language of the BM.

- *Sg. for pl.* *yadi ṣṣaḍbhi traya⟨ḫ pa⟩ṇā labhyate* (VIII 7); *si⟨d⟩dh⟨ā⟩rthā yāsyati* (X 1, '⟨Four⟩ *siddhārthas* will go').
- *Pl. for sg.* *(e)bhir dinai samagatī bhavanti navayojanaṃ* (III 7, 'In so many days, the nine-*yojana* ⟨goer⟩ gets his journey equal ⟨to the other's⟩'); *śarpo . . . apaharaṃti* (X 6); *yā nau . . . sā. . . nivartaṃte* (X 12).
- *Pl. for sg., but du. in sense.* *⟨rā⟩japutro dvayo keci nr̥patissevya santi vaiḥ* (VIII 5).

4.6.3 Stems

There occur several irregular stems.

- *āpnayā* (III 35) = *āpnuyāḥ* (opt. 2nd sg.). This may be a graphic error, but cf. the stem *āpuna-* in BHSG 43 (s.v. *āp-*) and *pāpuṇa-* (with *pra-*) in Pali (Geiger 148.2).
- *ārjayate* (VIII 4) = *arjati*, and *ārjaye* (VIII 3, 4) = *arjet*. Cf. *ārjayati* in BHSD. Cf. also *ārja* (VIII 3) and *ārjana* (IX 1).
- *kr̥ṇāti* (VIII 6) = *krīṇāti*, and *vikr̥ṇāti* (VIII 6, 7) = *vikrīṇāti* for *vikrīṇīte* ('He sells'). Cf. Pkt. *kiṇaï* (Pischel 511) and Pali *kiṇāti* (Geiger 21). Cf. also BHSG 28.5, which, following Oldenberg, suggests the probable reading *kriṇāti* for *krīṇāti* in R̥gveda 4.24.10 on the basis of the metrical evidence observed in similar cases such as *priṇanti*, etc.
- *kr̥̄te* = *krīṇīte*? in: *kaś⟨c⟩i⟨d dvācatvā⟩riṃśataṃ paṭakānāṃ paṇa* (inst.) *kr̥̄te* (VIII 10).
- *japa* (X 9, at the end of a Śloka) = *jalpa* (impv.). Probably derives m.c. from d. *jappa*. Cf. Pkt. *jaṃpaï/jappaï* (Pischel 296). For the reduction of double to single consonants, see Sec. 4.1.2 above.
- *lagyanti* (X 19) = *laganti*. Cf. *laggati/laggaï* in Pali/Pkt. (Geiger 136.2 and Pischel 488). Pischel and Geiger assumes the stem **lagyati* in order to connect *laggaï* to *lagati*. Yāska (*Nirukta* 4.10) lists the 3rd sg. *lagyati* also (B–R and MMW, s.v. *lag*).

4.6.4 Conjugation

Conjugation in the language of the BM shows nothing special except the loss of final consonants. Thus, *āpnayā* (III 35) = *āpnuyāḥ*; *kāraye* (IV 7) = *kārayet*; *gacche* (X 8, 15); *guṇaye* (I 10, etc.); *dāpaye* (X 17); *bhave* (III 35); *bhājaye* (VIII 7, etc.); *kuryā* (III 1, 4); *dadyā* (III 29, IX 2); *syā* (II 2, III 28); *katthyatā* (V 5) = *kathyatām*. For the opt. 3rd sg. in *-e*, see BHSG 29.12 and Geiger 127, 133, and 139; for the opt. 3rd sg. in *-yā*, see BHSG 29.42 and Pali *dajjā* (Geiger 143); and for the opt. 3rd sg. *syā* = *syāt*, see BHSG 29.41 and Pali *siyā* (Geiger 141).

In the present, besides the Ātmanepada *labhate*, we have, as in Pali and epic Sanskrit, the Parasmaipada *labhati* (X 24). We have also the Parasmaipada *vikṛṇāti* (= *vikrīṇāti*) for *vikrīṇīte* (VIII 6, 7). The 3rd sg. *bhukte* (X 16, = *bhuṅkte*) is probably a graphic error, and so also are the opt. 3rd sg. *bhājayeta* (III 33, = *bhājayet*) and *bhavetāṃ* (II 4, = *bhavet*, which is required by the meter), and the impv. 3rd sg. *ucyata* (III 6, = *ucyatām*) and *ucyateṃ* (VII 1, = *ucyatām*).

It is not certain whether ⟨*ādi*⟩*sāt* (VIII 9, = *ādiśet*) is a graphic error or a linguistic anomaly. The word *dade* (II 7) must be the Ātmanepada perfect 3rd sg. of *dā*, and not = opt. *dadet*, an example of which is cited in BHSG 43 (s.v. *dā*). But cf. the opt. 3rd sg. *dade* in Pali (Geiger 143). A long final *ā* is noticed in the perfect 3rd sg. *babhūvā* (III 31, = *babhūva*).

4.6.5 Verbals

Past Participles

- *pāteta* (VII 7) = *pātita*. For the confusion of *i*, *ī*, and *e*, see *i*, *ī* > *e*, and *e* > *i* in Sec. 4.1.1 above.
- *praṣṭa* (I 8, VII 11, VIII 2, 3) = *pṛṣṭa*. For the strong stem-forms used for the past passive participles, see BHSG 34.13, which cites, among other examples, the word *praṣṭa* from the *Mahāvastu*.
- *dattavān* with its logical subject in the inst. case. *prathamena dvitīyasya daśadīnāra* ⟨*da*⟩*ttavān* (VIII 5). Cf. the inst. for nom. in Sec. 4.2.3 above. For the inst. of the logical subject with an active verb, see BHSG 7.41. The same Parasmaipada past participle, *dattavān*, is probably used in the passive sense in: *caturdhāntasya lohasya ekāśītiś ca dattavān* (III 30). For similar usage of Parasmaipada past participles in Pkt., see Pischel 569.

Gerundives

- *niya* (III 16) = *neya*. Cf. *avinīya* (= *avineya*) cited in BHSG 3.48 & 34.27.
- *hartya* (V 6) = *hārya*. A false Skt. form from d. *hajja*? Or, from *hṛtya* with the lengthening of the root vowel *ṛ*?
- *Absolutives* accompanied by interogatives are used independently, i.e., without finite verbs, in: *datvā* ⟨*kiṃ ta*⟩*sya śarvāya* (X 13); *kai dinai bhūtale prāpya* (X 10).

4.7 Summary of Irregular Words

4.7.1 Irregular Sanskrit Words/Word-Forms

Out of a number of irregular words/word-forms that have been referred to in the foregoing sections, some noteworthy cases are listed below. This list does not contain pronouns and verbs, for which refer to their respective sections above.

- *aṃha* (III 23) = *ambhas*, 'water.' An *a*-stem noun.
- *adha* (I 10, etc.) = *adhas*, 'the lower.' An *a*-stem noun. See Sec. 4.5.3.
- *adhvāna* (III 11). The strong stem of *adhvan* ('way') used for the nom. sg. Cf. the nom. sg. *aḍḍhāṇo* in Pkt. (Pischel 402) and *adhvāna-* in BHSG 17.37–38.
- *ambha* (III 28, in '*ajñāta=r=ambhalohasya*') = *aśma-*, 'a stone.' See Sec. 4.1.2 (s.v. *śm* > *mbh*). Hoernle 1888, 48, equates *ambhaloha* to Skt. *abhraloha*, 'lapis lazuli.'
- *aha* (VIII 4, 5) = *ahas*, 'a day.' An *a*-stem noun.
- *āpa* (I 4, in '*paravaptrāpavaptṛkai*') = *ātma-*, 'one's own.' Cf. *appa* in M. and Ap. (Pischel 277 & 401), and *āpa* in LM 76.
- *ārja/ārjana* (VIII 3, IX 1) = *arjana*, 'earning.' Cf. *ārjanā* in BHSD.
- *-una* (I 3) = *-guṇa*, 'multiplied.' Cf. *-uṇa* in M. (Pischel 436).
- *upara* (I 10, etc.) = *upari*, 'the upper.' An *a*-stem noun. See Sec. 4.5.3.
- *uvānta* (I 4, in '*uvāntaṃ śataṃ*' = 190) = *upānta*, 'penultimate'?
- *ūrdha* (I 10, etc.) = *ūrdhva*, 'the upper.' A half Skt. form. Cf. *uddha* in Pkt. (Pischel 83 & 300) and in Pali (Geiger 59.3), and *ūrdha* in BHSD.
- *aika* (III 16) = *eka*, 'one.' A hyper-Skt. form. Cf. *pratyaika* below.
- *kaṭi/kaṭī* (III 15). A dialectic (*deśī*) word meaning 'alloy' or 'mixture'? Or, = Skt. *kṛti*, 'product'? Cf. Pali *kaṭa* = Skt. *kṛta*.
- *khandhaka* (X 25) = *skandhaka*, 'a section.' Cf. *khandha* in Pkt. (Pischel 306 and Geiger 62.1) and *khandhāvāra* in BHSG 2.12.
- *gadyūti* (III 23) = *gavyūti*, a linear measure.
- *gāvī* (VIII 3). A feminine form of *go*, 'a cow.' Cf. *gāvī* in Pali, AMg. and JM. (Pischel 393). Cf. also *yuvī* below.
- *ghana* (VII 1) = *ghna*, 'multiplied.' Cf. *hana* in S. (Pischel 132).
- *ṭala/ṭalla/ṭallikā* (V 6). A measure of capacity or weight.
- *tatti* (? V 5) = *tattaka/tattikā* ('so much, so many') in BHSD and in Pali (Geiger 111.6)? If we read *bhaḍḍi* instead of *tatti*, it is probably related to Skt. *bhaṇḍi* ('wave'). Another possible reading is *bhatti*, which would be = Skt. *bhakti*, 'a section.'
- *tseda* (II 9) = *ccheda*, 'division.' A hyper-Skt. form. See under *cch* > *ts* in Sec. 4.1.2 above.
- *datya* (I 4, in '*tṛbhir datyai*'). A false Skt. form from d. *dacca* = *dātva*, 'a donor'? Cf. *tv* (> *ty*) > *cc* in Pkt. (Pischel 299). Or, from d. *dacca* = **dātya* = *dātavya*, 'a gift' or 'a share holder'?

- *dandha* (III 19) = *dagdha*, 'burnt.' Cf. Pkt. *daḍḍha* (Pischel 222).
- *divardha* (I 14, etc.) = *adhyardha*, 'one and a half.' Cf. Pkt. *divaḍḍha* (Pischel 450 and Geiger 46.1), and Ap. *diyaḍḍha* (HGA 116).
- *dhānta* (III 19, etc.) = *dhmāta*, 'smelted.' Cf. *dhatta* in AMg. (Pischel 90), *dhanta* in Pali, and *nirdhānta* in BHSD. Hoernle 1888, 278, derives the word from the suffix *dhā* and *anta*, and gives the meaning 'installment.'
- *dhvānta* (III 19, 29) = *dhānta* above. A false Skt. from *dhānta*? Cf. *dhv-* > *dh-* in Pali (Geiger 53.3).
- *paṃtu* (I 15) = *pañca*, 'five.' A graphic error?
- *payasa* (V 2) = *payas*, 'milk.' An *a*-stem noun.
- *pariyoca* (III 16) = ?
- *pārtha* (III 19) = *prāsta*, 'cast out.' A false Skt. form from d. *pattha* (see the next item). Cf. *rth* > *tth* in M. (Pischel 288). Hoernle 1888, 278, takes the word to be a synonym of *pārthakya*, and gives the meaning 'series.'
- *pāsta* (III 23, 24, 27) = *prāsta*, 'cast out.' Cf. *pr* > *p* in Pkt. (Pischel 268 & 287) and in LM 110. Hoernle 1888, 278, takes the word to stand for *apāsta*, 'deduction.'
- *pāstha* (III 20, 28) = *prāsta*, 'cast out.' A false Skt. form from d. *pāsta* (see above)? Cf. *sth* > *st* in the BM (Sec. 4.1.2 above) and in Mg. (Pischel 310). Hoernle 1888, 278, takes *pāstha* to be an error for *pārtha*, or for *pāsta*.
- *pratyaika* (II 6, III 5, IV 3) = *pratyeka*, 'each.' Cf. *aika* above.
- *bhaḍḍi* (? V 5). See *tatti* above.
- *bhatti* (? V 5). See *tatti* above.
- *maṇaleā* (V 6) = *maṇḍalaka* (V 6) = *maṇḍalikā*. A measure of capacity or weight.
- *mūdṛ/mūdṛkā* (X 2, 3). A measure of weight.
- *meka* (VIII 5, etc.) = *eka*, 'one.' See under the *sandhi*-consonants in Sec. 4.1.3.
- *yuvī* (VII 12). A feminine form of d. *yuva* (an *a*-stem noun) = *yuvan*, 'young.' Cf. *gāvī* above.
- *vajara* (IX 3) = *vajra*. A monetary unit. For the addition of medial *a*, see Sec. 4.1.1.
- *vajjara* (VIX 2) = *vajra*. The form *vajjara* may have resulted from the crossing of *vajja* (assimilation) and *vajara* (see above) as in the case of Pali *aggini* < *aggi* + *agini*. Cf. Pischel 195, who cites AMg. *sassirīya* < *saśrīka*, etc. I owe this interpretation to J. Sakamoto-Goto.
- *vaṃsura* (II 9). A dialectical word meaning 'a troop'?
- *vekṣa* (III 27) = *vīkṣa*, 'a visible thing.'
- *śveya* (X 25) = *svīya*, 'one's own.'
- *saṃha* (X 15) = *saṃgha*, 'a group, flock.' Cf. *gh* > *h* in Pkt. (Pischel 188) and in BHSG 2.35.
- *saṅka* (III 2). A dialectical word meaning 'property'? Or, = *saṃkhyā*? Apparently used as a synonym of the word *dhana*.

- *sūḍha* (VII 11, 12) = *śūdra*, 'a man of *śūdra* cast.' Cf. *dr* > *ḍḍ* in Pkt. (Pischel 294).
- *skhandhaka* (X 25) = *skandhaka*, 'a section.' A false Skt. form from d. *khandhaka*, which occurs on the same page. Cf. initial *skh* > *kh* in Pkt. (Pischel 306) and in BHSG 2.12.

4.7.2 Sanskrit Words with Unusual Meanings

- *aprāpta* (III 35, 36), 'impure' or 'impurity' of gold. Cf. *prāpta* below.
- *āvṛtti* (III 23), 'the original quantity.' Given as a synonym of the word *pravṛtti*.
- *eka* (V 1), 'the total, sum.'
- *ekatra/ekattra* (I 1, etc.), 'the total, sum.' Declinable. See Sec. 4.5.3.
- *ekatva* (VIII 2), 'the total, sum.'
- *gaṇḍika/gaṇḍikā* (III 35, 36), 'alloy' or 'mixture.' B–R lists *gaṇḍakā* (a lump, ball) according to Wilson's dictionary. According to Indian lexicographers, *gaṇḍikā* has the meaning, 'anything advanced beyond the first stage or commencement' (B–R, s.v. *gaṇḍikā*; MMW, s.v. *gaṇḍaka*).
- *jīvaloka* (IV 2, X 19), 'stipend, maintenance.' Used as a synonym of *jīvyā*.
- *pada* (II 4), 'the value'? See Sec. 6.4.
- *prabhava* (III 15), 'the first term of a mathematical series.' The word is used in the same sense also by Mahāvīra (*Gaṇitasārasaṃgraha* Parikarma 61) and by Śrīdhara (*Pāṭīgaṇita* 90 & 99).
- *pravṛtti* (III 23, etc.), 'the original quantity to be increased or decreased.'
- *prāpta* (III 35), 'pure (gold).' Cf. *aprāpta* above.
- *varga* (IV 5, 6), = *saṃvarga* or *vargaṇā*, 'multiplication.' See Sec. 6.8.
- *vartya* (IV 5, etc.) = *apavartya*, 'to be reduced.'
- *śiras* (X 21, 22) = *patti*, the smallest division of an army. Cf. *śiras*, 'the van of an army,' in Skt. dictionaries.

4.8 Overlying Dialects

The above study of the linguistic peculiarites of the BM shows that the language of the BM, though intended to be Sanskrit, has been affected to a considerable degree by a dialect or dialects not only on the phonetic level but also on the morphologic level. Thus the language of the BM has a number of peculiarites in common with the so-called Buddhist hybrid Sanskrit as presented by Edgerton, although the evidence our text affords is not strong enough for establishing the language as an independent dialect.[3]

3 Hoernle 1888, 38, asserts that the BM is written 'in the so-called Gāthā dialect or in that literary form of the North-Western Prākṛit which preceded the employment, in secular composition, of the classical Sanskṛit.'

It is probable that most of the versified rules and examples of the BM had originally been composed in regular Sanskrit, since the irregularities found in them can be easily normalized without breaking the meter, but there are some others which contain the dropping of initial *a*, the *sandhi*-consonants, the inst. sg. ending *-e* for *a*-stem nouns, and so on: irregularities that are themselves in conformity with the meter.[4] This fact suggests the possibility that the BM is a loose compilation of rules and examples that have been collected from different works written in different dialects as well as in Sanskrit.

Naturally the dialect(s) overlying the Sanskrit of the BM has (have) strong affinity with Apabhraṃśa as presented by Pischel and Tagare, and, as is expected from the find-spot (Bakhshālī near Mardan) of the manuscript, also with Old Kashmīrī (LM). But I have not been able to identify the dialect(s) precisely. Section VII 11 (folio 46^v in Bodleian order) of the text is very interesting in this regard, as it is written wholly in a dialect. The page contains examples of the so-called Hundred Hens Problem (Sū C7). Although the dialect has not been completely deciphered yet, the following identifications of words and case-endings seem to be certain.

Words:

- *addha* = *ardha*, 'half,' as in Pkt. (Pischel 450) and Ap. (HGA 116).
- *arha* = *argha*, 'price,' or = *arha* (Tatsama).
- *āia* = *ādika*, 'and so on.'
- *ehu* = **eṣaṃ* = *etad*, 'this,' as in Ap. (Pischel 28, 263, and 426) and LM 222.
- *gaṇa* = *gaṇa* (Tatsama).
- *gora* = *ghoṭa*, 'a horse.' Cf. Ap. *ghoḍā* (Pischel 367) and Hindī *ghoḍā/ghorā*. For the disaspiration prevalent in Old Kashmīrī, see LM 36.
- *catuppaṇa* = *catuṣpaṇa*, 'four *paṇas*.'
- *jaṇa* = *jana*, 'a living being.'
- *jāma* = *yāvat*, 'as much, as many,' as in Ap. (Pischel 261).
- *trai-* = *tri-*, 'three.' Cf. *tre-* in the BM (Sec. 4.4.1) and in LM 210, and *tai-* in Ap. (HGA 107).
- *paṇa* = *paṇa* (Tatsama).
- *pārāa* = *pārāvata*, 'a pigeon' or 'a monkey,' as in Pkt. (Pischel 167).
- *vāraha* = *dvādaśa*, 'twelve,' as in Pkt. and Ap. (Pischel 443 and HGA 112, where *bāraha*). Cf. *vāha/bāha* in LM 217.
- *vīha* = *viṃśati*, 'twenty.' Cf. *cuvīha* (= *caturviṃśati*) and *śavvīha* (= *ṣaḍviṃśati*) in LM 217.
- *sāḍha* = *sādhya*, 'to be obtained.' Cf. *dh* > *ḍh* in Pkt. (Pischel 223), although *dhy* > *jjh* (Pischel 280).

4 See, for example, Ex. 1 for Sū N4 (I 15), Ex. 3 for Sū N6 (II 4), Ex. 7 for Sū N6 (II 7), Sū 10 (III 1), Sū 15 (III 6), Ex. 2 for Sū 19 (III 11), Ex. 1 for Sū 21 (III 15), Ex. 6 for Sū 25 (III 24), Ex. 1 for Sū C8 (VII 13), Ex. 1 for Sū 52 (VIII 3), Ex. 2 for Sū 53 (VIII 5), Ex. 1 for Sū 56 (VIII 8), Ex. 15 for Sū C10 (X 8), Ex. 16 for Sū C10 (X 9), Ex. 19 for Sū C10 (X 10), Ex. 25 for Sū C10 (X 13), Sū Q2 (III 12, VII 3, 6), and Sū Q5 (X 26).

- *sāmalea* = *śyāmalikā*, 'a dark colored (animal).' Cf. *sāmala* in Ap. (Pischel 100 & 346). For *-lea* = *-likā*, cf. *maṇaleā* (V 6) = *maṇḍalikā* = *maṇḍalaka* (V 6). B–R and MMW (s.v. *śyāmalaka*) list *śyāmalikā* with the meaning 'the indigo plant.' The adjective *śyāmala* usually means 'dark-colored,' and mainly modifies plants, but it denotes a kind of bee also. Cf. also *śyāmikā*, 'a white spotted blackish deer' (MMW, s.v. *śyāmaka*), and *śyāma*, 'the Kokila or Indian cuckoo' (MMW).

Case Endings:

- *Nom. sg. -a, -u.*
- *Loc. sg. -e.*
- *Nom. pl. -a, -e.*
- *Inst. pl. -ehi, -ahi* (for *vāraha* = *dvādaśa*).

All these endings occur in Apabhraṃśa (Pischel 363–364 and HGA 84–86); all, except the inst. pl. *-ehi* and *-ahi*, occur in the other parts of the BM and in LM 203; and all, except the inst. pl. *-ahi*, occur in BHSG 8.

Meter

Hoernle asserted that the Śloka (Anuṣṭubh) meter is exclusively used in the BM.[1] This was one of the bases on which he assigned the work to the third or fourth century A.D.[2] Kaye, silently accepting Hoernle's assertion, rightly refuted his argument that 'from about the end of the 5th century A.D. it became the fashion to use the āryā measure.'[3] In fact, however, meters other than Śloka do occur in the BM. Indravajrā and Vasantatilakā are used twice each, and Śārdūlavikrīḍita once, in the extant BM. Even the Āryā measure and its variations, Upagīti and Udgīti, seem to occur several times in the BM. There are other stanzas, which are so mutilated that I cannot determine their meters. Among them, I suspect, may be found some in Apabhraṃśa meters, though I am not in a position to clarify the matter.

In the following list, the references are to the section and the line in which the stanza begins.

- Śloka: I 1, 4; I 2, 2; I 4, 3 & 6; I 8, 6; I 15, 2; II 4, 1; II 7, 5; II 9, 4; III 1, 3, 7 & 8; III 5, 1; III 6, 2 & 7; III 7, 9; III 8, 5 & 6; III 11, 3; III 12, 3; III 14, 7; III 15, 1 & 2; III 16, 1 & 3; III 17, 1 & 2; III 19, 1 & 3; III 20, 7; III 21, 8; III 23, 1(?); III 24, 5; III 25, 4 & 7; III 26, 3; III 27, 1; III 28, 2 & 7; III 29, 1; III 30, 1 & 5; III 31, 5; III 32, 3 & 4; III 33, 3; III 34, 2; III 35, 2 & 3; III 36, 2 & 5; IV 1, 1; IV 4, 1 & 8; IV 5, 2 & 10; IV 6, 1 & 8; V 1(b), 1; V 3, 1(?); V 5, 1 & 3; VI 1, 1; VI 2, 1; VI 4, 6; VII 3, 2; VII 6, 4; VII 7, 7; VII 13, 2; VIII 2, 8; VIII 3, 4 & 6; VIII 4, 4 & 6; VIII 5, 5; VIII 6, 4 & 6; VIII 7, 6 & 8; VIII 8, 3 & 5; VIII 9, 3 & 5; VIII 10, 3 & 5; IX 1, 2; IX 2, 3; IX 3, 1; X 7, 7; X 8, 3; X 9, 1; X 10, 4; X 11, 1 & 8; X 12, 2 & 6; X 13, 1 & 5; X 15, 2 & 7; X 16, 4 & 8; X 22, 3 & 8; X 23, 1; X 24, 7 & 8; X 26, 1, 2, 4, & 6; X 27, 4.
- Indravajrā: X 7, 4; X 15, 1.
- Vasantatilakā: X 14, 1; X 15, 5.
- Śārdūlavikrīḍita: X 23, 7.
- Āryā: III 6, 4.
- Unidentified stanzas: III 3, 7; III 6, 8; III 7, 2, and 6; III 9, 6, and 8 (a *mātrā-vṛtta*); III 21, 1, and 5; III 27, 7; IV 2, 2; IV 7, 1; IV 8, 1 & 8; IV 9, 9; IV 11, 9; V 3, 1; VII 11, 2; VIII 2, 2; X 1, 1; X 2, 2; X 3, 1; X 4, 2; X 5, 7; X 6, 3 and 7; X 9, 8; X 11, 3; X 14, 4; X 21, 8.

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1 Hoernle 1888, 34.
2 Hoernle 1888, 36.
3 Kaye 1927/33, 79.

Some of the Śloka stanzas listed above contain the so-called hyper-metric *pāda*, that is, the octosyllabic quarter with an extra syllable. In the epic, it is said to occur in the odd (or prior) Śloka *pāda*,[4] but in our text it is found in the even *pāda* too. For example,

> *vihīyamānaṃ tu nityaśaḥ* (X 9, 5);
> *catuścatvāliṃśa saptati* (VII 13, 3);
> *yadi gaṇite kṛtaṃ śramaṃ* (III 30, 6); etc.

In the odd *pāda*:

> *paṃcārdhasaṃvatsare bhu⟨ṅ⟩kte* (X 16, 4);
> *aśītyādhikaṃ dhanaṃ caiva* (II 9, 6);
> *viparītayācanā kṣiptau* (III 1, 5);
> *dvitīya pratidine ssapta* (III 11, 4); etc.

See also: I 4, 6 (*uvāntaṃ*)[5]; III 11, 3 (*ādi paṃca*: this case could be reduced to the regular *pāda* by correcting the hiatus); III 25, 4 (*tṛbhāga*); III 31, 5 (*dvitīye*) and 6 (*tṛtīye*); IV 4, 2 (*prathamatrayaṃ*) and 3 (*prathamā*); V 5, 3 (*vaipulyād*); VI 1, 2 (*dvitīya*); VI 2, 2 (*dvitīya*) and 3 (*prathamaḥ*); VII 13, 3 (*catuṣṣaṣṭhi*); IX 2, 6 (*pādona*) and 8 (*sapaṃca*); X 10, 5 (*patitaṃ*); X 12, 8 (*yojanā*); and X 26, 2 (*dramme*).

The following *pāda*, which begins a Śloka stanza, contains ten syllables:

> *kasya⟨cid vāṇi⟩jjakasya ṣaṣṭhi* (III 26, 3).

The *vipulā pādas* found in the BM are listed below. The classification is according to H. Jacobi and E. W. Hopkins.[6] The symbols, ˘ , – , and □, indicate a short, a long, and an unknown syllables respectively.

1. First (*na*) *vipulā*: ˘ ˘ ˘ ≚ . Except a few cases, the caesura is located after the fifth syllable of the *pāda*.

   (a) ˘ – ˘ – : III 5, 1 (*pṛthag*).

   (b) ≚ – – – : III 32, 3 (*kṣayaṃ*); III 36, 2 (*ūnais*); III 36, 5 (*aprāpta-*); VIII 4, 6 (*dvitīyaṃ*); VIII 7, 6 (*rūpoṇe*); IX 3, 1 (*bhāṇḍāre*); X 13, 1 (*khāryā*).

   (c) – ˘ – – : III 11, 3 = III 14, 7 = VIII 5, 5 (*kena*); III 32, 3 (*saṃyutair*); X 12, 6 (*yojanā-*).

   (d) ˘ – – ˘ : X 23, 1 (*anīkīni*, in a citation from the *Mahābhārata*). With the normalization of the unusual word-form '*anīkīni*' to '*anīkinī*,' which is the original word in the *Mahābhārata*, the first foot of this *pāda* will be ˘ – ˘ – .

   (e) – ˘ – ˘ : X 26, 2 (*ekarāśika-*), after the correction of '*ekarāśis tu*' to '*ekarāśika-*.'

   (f) ˘ – – ˘ ˘ (hyper metric): VII 13, 2 (*catuṣ-*).

   (g) □□□□+□ ˘ ˘ – : X 26, 1. Cf. 2 (d) below.

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4 Hopkins 1901, 252–261.
5 The word in a pair of parentheses begins the stanza.
6 Jacobi 1885, 442–451 and Hopkins 1901, 236.

2. Second (*bha*) *vipulā*: – ⏑ ⏑ ⏓.

   (a) ⏓ – ⏑ –: III 1, 3 (*guṇaṃ*); III 6, 7 (*tenaiva*); III 8, 5 (*ādyor*); III 16, 3 (*niyo*); X 26, 6 (*adheṇa*).
   (b) – ⏑ – –: VIII 10, 3 (*vastra-*).
   (c) – – – – ⏑ (hyper metric): V 5, 3 (*vaipulyād*), in a restoration.
   (d) □□□□+□⏑ ⏑ –: X 26, 1. Cf. 1 (g) above.

3. Third (*ma*) *vipulā*: – ,– – ⏓.

   (a) ⏓ – ⏑ –: II 9, 4 (*dhanā*); III 1, 7 (*aṃśāṃ*); III 35, 3 (*māṣa-*) after the correction of the meaningless phrase '*māṣadvayāghrako*' to '*māṣād eko*,' but with an irregular caesura; VIII 10, 5 (*paṭasya*) after the normalization of '*śulka*' to '*śulkaṃ*' or '*śulko*,' otherwise the *pāda* is *pathyā*; X 22, 3 (*tasāyakaiś*); X 27, 4 (*ādyāvasāne*).
   (b) ⏓ – – –: III 26, 3 (*kā*); IV 4, 8 (*yadṛcchāṃ*) with an irregular caesura. The last case will become *pathyā* by normalizing '*vinyasyẹ*' to '*vinyaset*.'
   (c) – ⏑ – –: IV 5, 10 (*kāmikaṃ*); VIII 9, 5 (*rūpakena*), the first foot of which will become – ⏑ – ⏑ with the normalization of '*ṣṣaṭ*' to '*ṣaṭ*'; X 9, 1 (*yojanānāṃ*) in a restoration with an irregular caesura.
   (d) ⏑ – ⏑ ⏑: I 15, 2 (*tadā*), in a restoration.
   (e) □□□□: IX 2, 3 (*patra-*).

4. Fourth (*ra*) *vipulā*: – ⏑ – ⏓.

   (a) ⏓ – ⏑ –: VIII 7, 8 (*mūlā*), in a restoration; X 22, 3 (*samāhatā*).
   (b) ⏓ – – –: VI 4, 6 (*guṇābhyāso*); VIII 3, 6 (*bhāṇḍāgāraṃ*).
   (c) ⏑ – – ⏑: VII 13, 2 (*tṛrāśīti*); VI 2, 1 (*tṛtīyaścaturthayoś ca*). If we normalize the first '*śca*' to '*ca*,' the first foot of the last case will become ⏑ – ⏑ ⏑, a pattern whose combination with the fourth *vipulā* is questioned by Hopkins even in the epic.[7]
   (d) – – ⏑ ⏑ ⏑ (hyper metric): III 19, 3 (*aṣṭhottara-*).
   (e) – ⏑ – – – ⏑ (six-syllable foot): III 26, 4 (*kasya cid*).
   (f) The fourth *vipulā* is avoided by inserting one extra syllable '*ca*' in IX 2, 6: '*pādonatrayodaśānāṃ ca aṣṭasārdhadināni vait*.'

5. Minor Ionic: ⏑ ⏑ – ⏓.

   (a) – – ⏑ –: X 26, 4 (*sārdha-*).
   (b) ⏑ ⏑ – –: VIII 10, 5 (*paṭakānāṃ*), of which the second foot will become *pathyā* by assuming the value '*krī*' for '*kṝ*.'

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7 Hopkins 1901, 236.

(c) ⏑––⏑ : III 21, 8 (*caturbhāga-*), in a restoration.

6. Major Ionic: ––⏑ ⏓. This type occurs only once in a restoration of the first *pāda* of a long verse in V 3, which consists of more than twelve *pādas*, but it is not certain whether or not the stanza is in the Śloka measure: '*prathamasya bhāgo daśa dvitīyasya tu dvādaśa*' (V 3, 1). This case has not been included in the statistic calculation below.

7. Diiambus: ⏑–⏑ ⏓.

   (a) ––⏑– : III 28, 7 (*na*); III 35, 2 (*aprāpta-*), in a restoration.
   (b) ⏓––– : III 14, 7 (*ādyekaṃ*); III 16, 3 (*gaṃtavyaṃ*); IV 1, 1 (*tṛrūpaṃ*); IX 2, 3 (*arthaṃ*), in a restoration.
   (c) ⏓⏑–– : III 36, 5 (*gaṇḍikā-*), in a restoration; IX 2, 3 (*daśakaṃ*), the second foot of which will become *pathyā* by normalizing '*utpati*' to '*utpatti*'; IX 2, 7 (*satṛbhāgaṃ*).
   (d) –––⏑ : IX 3, 1 (*sārdha-*).
   (e) –⏑–⏑ : III 17, 1 (*uttareṇa*), in a restoration; X 12, 2 (*kīṭayā*), in a restoration.

No significant tendency seems to exist in the distribution of these *vipulā pādas* in the BM. The statistics given in Table 5.1 shows that the rate of the fourth *vipulā*, about 3 percent, is siginificantly higher than those of classical writers such as Kālidāsa (0.07 percent) and Bhartṛhari (0.30 percent) who are rather tolerant to the use of it in comparison with other classical writers such as Bhāravi, Māgha, and Bilhaṇa (0 percent).[8] But it is not surprisingly high from the Purāṇic standards (1.5 to 5.6 percent).[9]

Table 5.1: Statistics of *vipulā pādas* in the BM

Vipulā	First	Second	Third	Fourth	Minor I.	Diiambus
Number[10]	16	8	12	8	3	12
Rate (%)	5.9	3.0	4.4	3.0	1.1	4.4

Another thing that may be interesting is that the rate of the diiambic *pādas* is very high even from the epic standard,[11] though I can not draw any conclusion from this fact.

Irregular second feet of even *pādas* are noticed in the BM, though very rarely.

- ⏑⏑⏑⏑⏑–⏑– : VIII 10, 3 (*tad-*), in a restoration.
- ⏑–⏑––––⏑– : III 14, 7 (*dvitīya*).
- –––––––⏑– : VIII 10, 5 (*kaścid*).
- ⏑–––⏑–⏑––– : III 31, 6 (*tṛtīye*), in a restoration.
- ––⏑⏑⏑–––⏑ : I 15, 2 (*eka-*), the second foot of which will become ⏑––– by normalizing '*sa*' to '*saḥ*.'
- –⏑⏑–⏑⏑–⏑ : X 22, 3 (*hehaya-*), in a restorarion.

8 Rau 1977/78, 268–269.
9 Hopkins 1901, 224–236.
10 The grand total of the identified odd *pādas* is 271.
11 Hopkins 1901, 236.

CHAPTER 6

Special Terminology

6.1 aṃśa and cheda

The word *cheda* in the fourth *pāda* of Sūtra Q6 (X 17) is used to denote the numerator of a fraction, while the same word in the second *pāda* of the same stanza stands as usual for the denominator. The abbreviation, '*aṃ*', for *aṃśa* is used as a synonym of '*che*' for *cheda* meaning a conversion ratio in an enclosure in X 16. Moreover, the words, *ūrdhaccheda* (= *ūrdhva-*) and *adhaccheda* (= *adhaḥ-*), are used to denote respectively conversion ratios by which the 'upper' term and the 'lower' term of a fraction are to be multiplied.

Thus in our text the words *aṃśa* and *cheda* are used indiscriminately in the senses of a numerator, denominator, and a conversion ratio. In English, therefore, these words may be best translated 'a factor.'

6.2 karaṇī and karaṇi

In the extant BM, the two words *karaṇī* and *karaṇi* occur twice each, and stand respectively for the square root of a non-square number and the square of a number: *karaṇī* in III 12 and VII 1, and *karaṇi* in VII 9 and 10. However, this apparent differentiation of the meanings according to the word forms is probably a mere coincidence, as it is not known in other works, while it will be demonstrated below that the word *karaṇī* (or *karaṇi*, which seems to be a Middle Indic corruption) had the above two meanings which apparently contradict each other. The history of the word is certainly not like what has been conceived by Datta and Singh, who claim:

> The word *karaṇī* is found to have been used in the Śulba works and Prākrta literature as a term for the square root. In geometry, it means a 'side'. In later times the term is, however, reserved for a surd, i.e., a square root which cannot be evaluated, but which may be represented by a line.[1]

The word occurs very often in the Śulbasūtras (ca. 600 B.C. to A.D. 200 or later), where it is used as a modifier of the word *rajju* ('a rope'), which is sometimes to be understood. Since the word *rajju* is a feminine noun, the adjective *karaṇa* ('making') takes the feminine form. For example, the diagonal of a square figure is termed *dvikaraṇī*, or 'a ⟨rope⟩ making ⟨a square⟩ twice ⟨as large as the original square⟩.'

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1 Datta and Singh 1935/38, Part 1, p. 170.

Āpastamba explains the term *dvikaraṇī* thus:

> *caturaśrasyākṣṇayārajjur dvistāvatīṃ bhūmiṃ karoti. samasya dvikaraṇī.*[2]
>
> The diagonal of a square, ⟨when a square is constructed on it⟩, makes a plane twice as large ⟨as the original square⟩. ⟨The diagonal⟩ of the square ⟨is, therefore, called its⟩ '*dvikaraṇī.*'

It should be remembered here that in the Śulbasūtras the word *karaṇī* is never used to denote the square root of a number, although it could mean a side of a square secondarily.[3]

The elder Āryabhaṭa (born A.D. 476) frequently uses the words *varga* and *kṛti* for the square power, and the word *mūla* for the square root, but he never employs the word *karaṇī* in either of those senses.

The word *karaṇī* is used four times in the *Pañcasiddhāntikā* (ca. A.D. 550), all in the sense of the square power.[4] Interestingly, its use is confined to a very small portion of the work, while the words *varga* and *kṛti* are used from place to place. The source of the portion has not been identified.[5]

The elder Bhāskara, in his commentary (A.D. 629) on the *Āryabhaṭīya*, uses the two forms *karaṇī* and *karaṇi* indiscriminately in several senses. he says:

> *vargaḥ karaṇī kṛtir vargaṇā yāvakaraṇam iti paryāyāḥ.*[6]
>
> *Varga, karaṇī, kṛti, vargaṇā*, and *yāvakaraṇa* are synonymous.

Here, the term *karaṇī* is taken to be a synonym of *varga* ('the square'). It is employed in this sense when he states:

> *ardham ity atra karaṇitvād dvayoḥ karaṇībhiś caturbhir hriyate.*[7]
>
> Half is said to be taken. Since in this case ⟨the quantity to be halved⟩ has the state of being a *karaṇi*, ⟨the quantity⟩ is divided by the *karaṇī* of two, i.e., by four.

He also uses the word in the sense of a number whose square root is to be taken. The following passage clearly shows this aspect of the word.

> *tatpunaḥ kṣetraphalaṃ mūlakriyamānaṃ karaṇitvaṃ pratipadyate yasmāt karaṇīnāṃ mūla⟨m apekṣitam⟩.*[8]
>
> But the area, when its square root is being taken, obtains the state of being a *karaṇi*, because the square root is required of a *karaṇī*.

The word is further used to denote the square root of a non-square number in a citation from an unidentified Prakrit source (probably of the Jainas). Bhāskara too employs the word in that sense in his comment on it.

> *'vikkhaṃbhavaggadasaguṇakaraṇī vaṭṭassa parirao hodi.' ... aparibhāṣitapramāṇatvāt karaṇīnām.*[9]

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2 *Āpastambaśulbasūtra* 1.5.
3 See, for example, *Baudhāyanaśulbasūtra* 1. 54.
4 Varāhamihira, *Pañcasiddhāntikā* 4.2–5.
5 See Pingree's Introduction to his edition of the *Pañcasiddhāntikā*.
6 Bhāskara, *bhāṣya* on *Āryabhaṭīya* 2.3.
7 Bhāskara, *bhāṣya* on *Āryabhaṭīya* 2.6.
8 Bhāskara, *bhāṣya* on *Āryabhaṭīya* 2.7cd (p. 61).
9 Bhāskara, *bhāṣya* on *Āryabhaṭīya* 2.10 (p. 72).

'The square root of the product of ten and the square of the diameter of a circle is its circumference.' ... because the magnitude of a *karaṇī* cannot be stated exactly.[10]

While discussing two divisions of mathematics, *rāśigaṇita* ('arithmetic of quantities') and *kṣetragaṇita* ('arithmetic of geometrical figures'), Bhāskara cites a hemistich from an unidentified source:

evaṃ karaṇīparikarma — karṇabhujayoḥ samatvaṃ karoti yasmāt tataḥ karaṇī.[11]

Likewise, the arithmetic of *karaṇīs* ⟨has the two aspects: *rāśigaṇita* and *kṣetragaṇita*⟩. 'The *karaṇī* is ⟨so called⟩ because it makes (*karoti*) the equation of the diagonal (c) and the sides (a and b) ⟨of a rectangle⟩ ($a^2 + b^2 = c^2$).'

What is intended here by Bhāskara is to relate the word *karaṇī* used in arithmetical operations involving *karaṇīs* (i.e., the squares of surds) to that used in the geometry of the Śulbasūtras. For this purpose, he cites the hemistich, the basic idea of which is that the verb *kṛ* has the implication of the squaring or the square power. I do not know whether or not this idea represents a historical fact, but it certainly explains the fact that the word *kṛti*, which has been derived from the same verb *kṛ*, was used as frequently as *varga* in the sense of the square power since at least the time of Āryabhaṭa.[12]

In the *Sūryasiddhānta* (ca. A.D. 800), a certain factor in the computation of the Sine of the sun's altitude is called *karaṇī*.[13] This naming is based on the way the factor is employed in the succeeding computation:

$$\text{Sine of the sun's altitude} = \sqrt{k + p^2} \pm p,$$

where another factor (p) called *phala* ('a fruit') is squared and added to the quantity (k) called *karaṇī*, which is, therefore, itself regarded as being in the dimension of the square power. Burgess has rightly remarked that the factor is 'styled *karaṇī* ... as being the square of a line whish is not, and cannot be, drawn,' though he is not justified in translating the term 'surd.'[14]

The anonymous commentator of Śrīdhara's *Pāṭīgaṇita* (8th century) employs the term *karaṇī* in connection with a square root, and cites a half stanza which admits its two meanings:

ato mūlam ity ukte karaṇītvaṃ prasajyate yad uktam — grāhyamūlo 'tha mūlaś ca karaṇīsaṃjñitāv ubhau.[15]

As the square root is declared ⟨to be taken⟩ from it, the state of being a *karaṇī* is attached ⟨to that number⟩. So has it been said: 'Both the ⟨number⟩ whose square root is to be taken and the square root ⟨itself⟩ are called *karaṇī*.'

The younger Āryabhaṭa (ca. A.D. 950/1500) uses the word *karaṇī* only in the sense of the greatest common divisor. This usage seems to be peculiar to him.

anyonyaṃ bhājyaharau vibhajet tāvan niragratāṃ gacchet,
kaścic chodhaś chedaḥ karaṇīsaṃjño 'tra jñeyaḥ.[16]

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10 For the details of Bhāskara's argument, see Sec. 6.5 below.
11 Bhāskara, *bhāṣya* on *Āryabhaṭīya*, Introduction to the gaṇitapāda (p. 44).
12 Cf. *tāvatkṛtvas kṛ* ('to square') recorded in Skt. dictionaries.
13 Sūryasiddhānta 3.28–34.
14 Burgess 1860, 255–259.
15 Anon. comm. on *Pāṭīgaṇita* 14 (p. 8).
16 Āryabhaṭa, *Mahāsiddhānta* 18.65.

One should divide the dividend and the divisor mutually until it reaches the state of having no remainder. Such a divisor that leaves no remainder is, it should be known here, called *karaṇī*.

Śrīpati (A.D. 1039/1056) in his book of *pāṭī* or algorithm uses the term *karaṇī* in the sense of the square power,[17] while in a chapter called *avyaktagaṇita* ('mathematics of unknown quantities') of his astronomical treatise he defines the term thus:

grāhyaṃ na mūlaṃ khalu yasya rāśes tasya pradiṣṭaṃ karaṇīti nāma.[18]

The name *karaṇī* has been given to a number whose square root should be obtained but, speaking exactly, does not exist.

Other orthodox Hindu mathematicians such as Brahmagupta (born A.D. 598) and the youger Bhāskara (born A.D. 1114) also used the term in the same sense, although they did not give its definition.[19] Also, Mahāvīra, a Jaina mathematician of the ninth century, used the word *karaṇi* with the short final vowel in that sense when he prescribed a rule for the addition and subtraction of surds.[20] Gaṇeśa (A.D. 1545), a famous scholiast on the *Līlāvatī*, explains the term thus:

yasya mūle gṛhyamāṇe samyaṅmūlaṃ na labhyate tannāma karaṇī. tadupacārād vargarāśer api mūle gṛhyamāṇe karaṇīty ucyate. pūrveṣāṃ pāribhāṣikīyaṃ saṃjñā. tathā cāhuḥ — mūlaṃ grāhyaṃ rāśes tu yasya karaṇīti nāma tasya syād iti.[21]

A certain ⟨number⟩, whose square root is being extracted but cannot be obtained exactly, is called *karaṇī*. In its secondary application, even a square number, when its square root is being extracted, is called *karaṇī*. This is a technical term of ⟨our⟩ predecessors. Thus, they say: 'The name of the number whose square root is to be taken is *karaṇī*.'

The above suvey of the word *karaṇī* (and *karaṇi*) is not at all exhaustive, but is enough to show that the term was, in mathematical works, used at least in five different senses which, except for one, are closely related to each other: all the later meanings of the word, except that of the younger Āryabhaṭa, originate from its usage in the Śulbasūtras, although the exact processes of their derivations are not always certain.

1. 'Making ⟨a square figure⟩,' in the Śulbasūtras.
2. 'The square power' or 'a number in the square power,' in the *Pañcasiddhāntikā*, in Bhāskara's *Āryabhaṭīyabhāṣya*, in the *Sūryasiddhānta*, in the *Gaṇitatilaka*, and in the BM.
3. 'The square root.'
   (a) 'The square root of a non-square number,' in the Prakrit sources cited in Bhāskara's *Āryabhaṭīyabhāṣya*, in the *Āryabhaṭīyabhāṣya* itself, and in the BM.
   (b) 'The square root in general,' in the Sanskrit source cited in the anon. comm. on Śrīdhara's *Pāṭīgaṇita*.

17 Śrīpati, *Gaṇitatilaka*, p. 50.
18 Śrīpati, *Siddhāntaśekhara* 14.7ab.
19 Brahmagupta, *Brāhmasphuṭasiddhānta* 18.38–40; Bhāskara, *Bījagaṇita* 34–49.
20 Mahāvīra, *Gaṇitasārasaṃgraha*, kṣetra $88\frac{1}{2}$– $89\frac{1}{2}$.
21 Gaṇeśa, *Buddhivilāsinī* on *Līlāvatī* 140.

4. 'A number, square or non-sqaure, whose root is required,' in the *Brāhmasphuṭasiddhānta*, in the *Āryabhaṭīyabhāṣya*, in the *Gaṇitasārasaṃgraha*, in the Sanskrit source cited in the anon. comm. on Śrīdhara's *Pāṭīgaṇita*, in the *Siddhāntaśekhara*, in Bhāskara's *Bījagaṇita*, and in Gaṇeśa's *Buddhivilāsinī* on the *Līlāvatī*.

5. 'The greatest common divisor,' in the *Mahāsiddhānta*.

6.3 koṭi and niyuta

In Example 19 for Sūtra C10 (in X 10), the height of Brahmaloka (Brahman's World) from the surface of the earth, 146,500,000 *yojanas*, is expressed as *'caturdaśas tu koṭṭī⟨nāṃ ni⟩yatapaṃcaśaṣṭhi ca,'* where the word *koṭṭi* and *niyata* denote respectively the eighth and the sixth decimal places. There is no doubt that the former is equivalent to Skt. *koṭi*, which too occurs in X 15, and the latter to Skt. *niyuta*:

$$\textit{koṭṭi} = \textit{koṭi} = 10^7$$
$$\textit{niyata} = \textit{niyuta} = 10^5.$$

The reduplication of consonants is not rare in the language of the BM; but the apparent euphonic change, $u > a$, in *niyata* may well be a graphic error due to the scribe, since we have only one other example of it in *āpnayā* (III 35) = *āpnuyāḥ*. Note, however, the form *nayuta*, which is often substituted for *niyuta* in Buddhist Sanskrit literature.[22]

The term *niyuta* for 10^5 is of Vedic origin (Table 6.1). It occurs in the tables of numeral denominations of the *Vājasaneyī Saṃhitā*, etc. In the *Kāṭhaka Saṃhitā*, it stands for 10^6. The word, often in the form *nayuta*, occurs also in Buddhist Sanskrit works such as the *Mahāvastu* and *Lalitavistara*; but there it represents 10^{12} except in one place of the *Mahāvyutpatti*, where as in the *Kāṭhaka Saṃhitā* it stands for 10^6.[23]

In the table of decimal places of the *Āryabhaṭīya*, as well as in that of the later *Pauliśasiddhānta*, whose astronomy is mainly based on Āryabhaṭa's works,[24] *niyuta* occurs as the term for 10^5 as in the majority of Vedic texts; but subsequently, in mathematical texts, it was replaced by the term *lakṣa* of non-Vedic origin (Table 6.2). It seems that the term *niyuta* disappeared from the main stream of Indian mathematics a little after the later *Pauliśasiddhānta* (ca. A.D. 700–800). The fact that the elder Bhāskara (A.D. 629), in commenting on the said table of the *Āryabhaṭīya*, gives the alternative *lakṣa* may indicate that the latter had become more popular than the former by his time.[25] The term *lakṣa* is found to have been used for 10^5 still earlier in non-mathematical Sanskrit works.[26] Paḷi dictionaries mention *lakkha* (= Skt. *lakṣa*) used for 10^5 in Buddhist canons.

The term *koṭi* for 10^7, on the other hand, does not occur in the Vedic tables. But it occurs in the *smṛti* literature (such as the *Manusmṛti*) and epic, which were composed in the early centuries of the Chiristian era (Table 6.5). Pali dictionaries mention *koṭi* (= 10^7) used still earlier in Buddhist canons.

22 Edgerton 1953, Vol. 2, s.v. *nayuta*.
23 Edgerton, loc. cit. Cf. Pali *nahuta* for 10^4.
24 Pingree 1969, 173.
25 Bhāskara, *bhāṣya* on *Āryabhaṭīya* 2.2.
26 See *Yājñavalkyasmṛti* (3rd or 4th century, or later?) 3.102; Vasubandhu (5th century), *bhāṣya* on *Abhidharmakośa* 3.93–94 (Table 6.3, AKB); and *Amarakośa* (6th or 7th century?) 3.5.24ab.

In mathematics, the term *koṭi* appears in the list of the *Āryabhaṭīya*, oldest of all extant mathematical texts (Table 6.2, AB). Consequently in the list, the term *arbuda*, which had occupied the eighth place in the Vedic tables, was pushed down to the next (ninth) place.[27] Later Hindu mathematicians followed him in this regard. But the list of the later *Pauliśasiddhānta* was further expanded by inserting five terms between the *arbuda* (10^8) of the *Āryabhaṭīya* and the *samudra* (10^9) of the *Vājasaneyī Saṃhitā*, etc. Out of those five terms, *padma* and *nikharva* are found to have been used previously in the *Jaiminīya Upaniṣad Brāhmaṇa* (Table 6.1, JUB).

Table 6.2 clearly illustrates that the Hindu (as against the Jaina and Buddhist) names of decimal places developed from those of the Vedic Saṃhitās. It is also noteworthy that the length of the lists was fixed at eighteen decimal places in Hindu mathematical texts.

The list of Mahāvīra, a Jaina mathematician of the ninth century, has a different structure (Table 6.4, GSS). It has twenty-four decimal places, and its naming of higher places is based on the centesimal scale, which was popular among the Buddhist and Jaina as well as Hindu people since probably pre-Christian times.[28] Mahāvīra's list itself has *lakṣa* for 10^5, but he uses the word *niyuta* in that sense in an example of the same work.[29]

The two lists given in Chapter 101 of the *Vāyupurāṇa* (Table 6.6) are archaic in character. The term *lakṣa* (= 10^5) does not occur in either of them; even *koṭi* does not seem to have obtained a popularity sufficient for its replacing the Vedic *arbuda* completely; there is great confusion, from the view point of the later Hindu mathematicians, in the latter half of the two lists; and the concurrence of both lists in one chapter itself indicates a state of confusion. Hazra assigns, though with hesitation, Chapter 101 of the *Vāyupurāṇa* to the third or fourth century A.D.[30]

Kṣīrasvāmin (11th century), in his commentary on the *Amarakośa*, cites from an unidentified source two stanzas that give a table of eighteen decimal places (Table 6.7). It will be observed that the first nine terms of that table are exactly the same as those of the *Kāṭhaka Saṃhitā* (Table 6.1, KS1 and KS2). For the sixth and the eighth places, however, the authority of Kṣīrasvāmin also gives the non-Vedic alternatives *lakṣa* and *koṭi* respectively.

The table recorded by al-Bīrūnī (ca. A.D. 1030) as a standard one (Table 6.7) resembles that of Kṣīrasvāmin, the only difference being found in the seventh place. Also, al-Bīrūnī's table is the same as that of the later Hindu mathematicians (Table 6.2, PG, etc.) with minor variations in the ninth, sixteenth, and the seventeenth decimal places.

Bhojarāja (A.D. 1005/55), in Chapter 9 (on *hasta*-ruler) of his book on architecture, has recorded an archaic list (Table 6.7), which, like the second list of the *Vāyupurāṇa* (Table 6.6, VP2), preserves the Vedic terms *niyuta* and *arbuda*. He, however, employs the non-Vedic *lakṣa* and *koṭi* when he describes the size of the earth in the chapter on Purāṇic cosmography (*bhuvanakośa*) of the same book.[31] Later in the same chapter, when he gives the heights of the planets and seven *lokas* ('Worlds'), he uses the Vedic *niyuta* and the non-Vedic *koṭi* in one and the same passage.[32] Notably, the example of the BM in which *koṭi* and *niyuta* occur is based on Purāṇic cosmography (see Sec. 13.2.3 below).

The above survey of the terminology for the decimal notation shows that the word *niyuta* of Vedic origin disappeared from at least formal tables of decimal places a little after the later *Pauliśa-*

27 Cf. similar cases caused by *badva* in KS2, and by *nikharvaka* in PB (Table 6.1).

28 Cf. Table 6.3, LV; Table 6.4, AD; and Table 6.5.

29 Mahāvīra, *Gaṇitasārasaṃgraha*, trairāśika 39.

30 Hazra 1940/75, 16–17.

31 Bhojarāja, *Samarāṅgaṇasūtradhāra* 5.1–5.

32 Bhojarāja, *Samarāṅgaṇasūtradhāra* 5.85–95.

siddhānta (ca. A.D. 700–800), but that it continued to be used sporadically still later.

Table 6.1: Vedic Names of Powers of Ten[33]

	TS=VS	MaitS	KS1	KS2	PB	JUB	SSS
10^0	*eka*	*eka*	*eka*	*eka*	*eka*	*eka*	*eka*
10^1	*daśa*	*daśa*	*daśa*	*daśa*	*daśa*	*daśa*	*daśa*
10^2	*śata*	*śata*	*śata*	*śata*	*śata*	*śata*	*śata*
10^3	*sahasra*	*sahasra*	*sahasra*	*sahasra*	*sahasra*	*sahasra*	*sahasra*
10^4	*ayuta*	*ayuta*	*ayuta*	*ayuta*	*ayuta*	*ayuta*	*ayuta*
10^5	*niyuta*	*prayuta*	*prayuta*	*prayuta*	*niyuta*	*niyuta*	*niyuta*
10^6	*prayuta*	*ayuta*	*niyuta*	*niyuta*	*prayuta*	*prayuta*	*prayuta*
10^7	*arbuda*	*arbuda*	*arbuda*	*arbuda*	*arbuda*	*arbuda*	*arbuda*
10^8	*nyarbuda*	*nyarbuda*	*nyarbuda*	*nyarbuda*	*nyarbuda*	*nyarbuda*	*nyarbuda*
10^9	*samudra*	*samudra*	*samudra*	*badva*	*nikharvaka*	*nikharva*	*nikharvāda*
10^{10}	*madhya*	*madhya*	*madhya*	*samudra*	*badva*	*padma*	*samudra*
10^{11}	*anta*	*anta*	*anta*	*madhya*	*akṣita*	*akṣiti*	*salila*
10^{12}	*parārdha*	*parārdha*	*parārdha*	*anta*	*go*	*vyomānta*	*antya*
10^{13}	–	–	–	*parārdha*	–	–	*ananta*

Abbreviations: VS = *Vājasaneyī Saṃhitā* 17.2 ff.; TS = *Taittirīya Saṃhitā* 4.4.11.4 and 7.2.20; KS1 = *Kāṭhaka Saṃhitā* 17.10; KS2 = *Kāṭhaka Saṃhitā* 39.6; MaitS = *Maitrāyaṇī Saṃhitā* 2.8.14; PB = *Pañcaviṃśa Brāhmaṇa* 17.14.2; JUB = *Jaiminīya Upaniṣad Brāhmaṇa* 1.10.28–29; SSS = *Śāṅkhāyana Śrauta Sūtra* 15.11.7.

Table 6.2: Names of Decimal Places by Hindu Mathematicians

	TS=VS[34]	AB	LP[35]	PG=Tr=GT=L=GK
10^0	*eka*	*eka*	*eka*	*eka*
10^1	*daśa*	*daśa*	*daśa*	*daśa*
10^2	*śata*	*śata*	*śata*	*śata*
10^3	*sahasra*	*sahasra*	*sahasra*	*sahasra*
10^4	*ayuta*	*ayuta*	*ayuta*	*ayuta*
10^5	*niyuta*	*niyuta*[36]	*niyuta*	lakṣa
				to be continued

33 This table has been constructed according to Macdonell and Keith 1912, Vol. 1, 342–343 (s.v. *daśan*).

34 This Vedic table is cited here for the sake of comparison.

35 This table has been reconstructed from what al-Bīrūnī tells us about the list of decimal places of the *Puliśasiddhānta* (sic). See his *India*, trans., Part 1, p. 177. He first lists the names of the fourth to the tenth places thus:

> *sahasram, ayutam, niyutam, prayutam, koṭi, arbudam,* and *kharva*;

and says that the rest, 'from the 11th to the 18th,' are the same as those of the table previously given by him as a standard one (see Table 6.7). Here must be a missing term, because he is talking about a table of eighteen decimal places. It is most probable that he mistakenly assigned the term *kharva* to the tenth place. Pingree 1969, 186, however, takes the last eight terms (*kharva* to *parārdha*) to denote the tenth to the seventeenth places.

36 Bhāskara (A.D. 629), the commentator, gives the alternative *lakṣa*.

Names of Decimal Places by Hindu Mathematicians (*continued*)

10^{6}	*prayuta*	*prayuta*	*prayuta*	*prayuta*
10^{7}	*arbuda*	koṭi	*koṭi*	*koṭi*
10^{8}	*nyarbuda*	*arbuda*	*arbuda*	*arbuda*
10^{9}	*samudra*	*vṛnda*	? (*padma*?)	*padma*[37]
10^{10}	*madhya*	–	*kharva*	*kharva*
10^{11}	*anta*	–	*nikharva*	*nikharva*
10^{12}	*parārdha*	–	*mahāpadma*	*mahāpadma*[38]
10^{13}	–	–	*śaṅku*	*śaṅku*
10^{14}	–	–	*samudra*	*samudra*[39]
10^{15}	–	–	*madhya*	*antya*
10^{16}	–	–	*antya*	*madhya*
10^{17}	–	–	*parārdha*	*parārdha*

Abbreviations: AB = *Āryabhaṭīya* 2.2; LP = Later *Pauliśasiddhānta* as cited in al-Bīrūnī's *India*, trans., Part 1, p. 177; PG = *Pāṭīgaṇita* 7–8; Tr = *Triśatikā*, paribhāṣā 2–3; GT = *Gaṇitatilaka* 2–3; L = *Līlāvatī* 10–11; GK = *Gaṇitakaumudī* 2–3.

Table 6.3: Names of Decimal Places by Buddhists

	LV[40]	AKB		LV	AKB
10^{0}	–	*eka*	10^{30}	⟨*mahā-*⟩	*mahā-*
10^{1}	–	*daśa*	10^{31}	*hetuhila*	*karabha*
10^{2}	–	*śata*	10^{32}	⟨*mahā-*⟩	*mahā-*
10^{3}	–	*sahasra*	10^{33}	*karaku/karahu*	*indra*
10^{4}	–	*prabheda*	10^{34}	⟨*mahā-*⟩	*mahā-*
10^{5}	–	*lakṣa*	10^{35}	*hetvindriya*	*samāpta*
10^{6}	–	*atilakṣa*	10^{36}	⟨*mahā-*⟩	*mahā-*
10^{7}	*koṭi*	*koṭi/kauṭi*	10^{37}	*samāptalambha*	*gati*
10^{8}	⟨*mahākoṭi*?⟩	*madhya*	10^{38}	⟨*mahā-*⟩	*mahā-*
10^{9}	*ayuta*	*ayuta*	10^{39}	*gaṇanāgati*	*nimbarajas*
10^{10}	⟨*mahā-*⟩	*mahā-*	10^{40}	⟨*mahā-*⟩	*mahā-*
10^{11}	*niyuta*	*niyuta*	10^{41}	*niravadya*	*mudrā*
10^{12}	⟨*mahā-*⟩	*mahā-*	10^{42}	⟨*mahā-*⟩	*mahā-*
10^{13}	*kaṅkara*	*prayuta*	10^{43}	*mudrābala*	*bala*
10^{14}	⟨*mahā-*⟩	*mahā-*	10^{44}	⟨*mahā-*⟩	*mahā-*
10^{15}	*vivara*	*kaṅkara*	10^{45}	*sarvabala*	*saṃjñā*
10^{16}	⟨*mahā-*⟩	*mahā-*	10^{46}	⟨*mahā-*⟩	*mahā-*
					to be continued

37 *abja* in PG, Tr, and L, *saroja* in GK.

38 *mahāsaroja* in PG, Tr, and GT, *mahābja* in GK.

39 *saritpati* in PG and Tr, *jaladhi* in L, *pārāvāra* in GK.

40 The LV gives *koṭi*, etc. on the centesimal scale, being silent about the names of even powers of ten. It is not certain whether the LV knew the place-value notation or not.

Names of Decimal Places by Buddhists (*continued*)

10^{17}	*akṣobhya*	*visvara*	10^{47}	*visaṃjñagatī*	*vibhūta*
10^{18}	⟨*mahā-*⟩	*mahā-*	10^{48}	⟨*mahā-*⟩	*mahā-*
10^{19}	*vivāha*	*akṣobhya*	10^{49}	*sarvasaṃjñā*	*balākṣa*
10^{20}	⟨*mahā-*⟩	*mahā-*	10^{50}	⟨*mahā-*⟩	*mahā-*
10^{21}	*utsaṅga*	*vivāha*	10^{51}	*vibhūtaṅgamā*	?[41]
10^{22}	⟨*mahā-*⟩	*mahā-*	10^{52}	⟨*mahā-*⟩	?
10^{23}	*bahula*	*utsaṅga*	10^{53}	*tallakṣaṇa*[42]	?
10^{24}	⟨*mahā-*⟩	*mahā-*	10^{54}	–	?
10^{25}	*nāgabala*	*vāhana*	10^{55}	–	?
10^{26}	⟨*mahā-*⟩	*mahā-*	10^{56}	–	?
10^{27}	*tiṭilambha*	*tiṭibha*	10^{57}	–	?
10^{28}	⟨*mahā-*⟩	*mahā-*	10^{58}	–	?
10^{29}	*vyavasthā-naprajñapti*	*hetu*	10^{59}	–	*asaṃkhya*

Abbreviations: LV = *Lalitavistara*, Chapter 12; AKB = *bhāṣya* on *Abhidharmakośa* 3.93–94.

Table 6.4: Names of Decimal Places by Jainas

	AD[43]	GSS		GSS
10^0	*ekka*	*eka*	10^{12}	*kharva*
10^1	*dasa/dasaga*	*daśa*	10^{13}	*mahākharva*
10^2	*sata/saya*	*śata*	10^{14}	*padma*
10^3	*sahassa*	*sahasra*	10^{15}	*mahāpadma*
10^4	*dasasahassa*	*daśasahasra*	10^{16}	*kṣoṇi*
10^5	*satasahassa*	*lakṣa*	10^{17}	*mahākṣoṇi*
10^6	*dasasatasahassa*	*daśalakṣa*	10^{18}	*śaṅkha*
10^7	*koḍi*	*koṭi*	10^{19}	*mahāśaṅkha*
10^8	*dasakoḍi*	*daśakoṭi*	10^{20}	*kṣiti*
10^9	*koḍisata*	*śatakoṭi*	10^{21}	*mahākṣiti*
10^{10}	*dasakoḍisata*	*arbuda*	10^{22}	*kṣobha*
10^{11}	–	*nyarbuda*	10^{23}	*mahākṣobha*

Abbreviations: AD = *Aṇuogaddārāiṃ* 204 and 326; GSS = *Gaṇitasārasaṃgraha*, paribhāṣā 63–68.

41 The AKB says: '... Ten *mahābalākṣas* make one *asaṃkhya* (lit. 'innumerable'). Eight ⟨names⟩ from the middle have been forgotten' (*daśa mahābalākṣāṇy asaṃkhyam. aṣṭakaṃ madhyād vistṛtam.*); and calls the last number (*asaṃkhya*) 'the number in sixty different places' (*ṣaṣṭisthānāntaragatā saṃkhyā*).

42 The LV further gives the following eight names which are said to come after *tallakṣaṇa*, but their values are uncertain: *dhvajāgravatī, dhvajāgraniśāmaṇī, vāhanaprajñapti, iṅga, kuruṭu/kuruṭa, kuruṭāvi, sarvanikṣepa* (= 10 *dhvajāgravatī*), *agrasārā* (= 10^9 *dhvajāgravatī*).

43 The AD is written in Prakrit. It is not certain whether the AD knew the place-value notation or not.

Table 6.5: Names of Powers of Ten in the *Rāmāyaṇa*[44]

	Lahole	Baroda	Bombay/Gorakhpur
10^7	*koṭi*	*koṭi*	*koṭi*
10^{12}	*śaṅku*	*śaṅku*	*śaṅkha/śaṅku*
10^{17}	*vṛnda*	*mahāśaṅku*	*mahāśaṅkha/mahāśaṅku*
10^{22}	*mahāvṛnda*	*vṛnda*	*vṛnda*
10^{27}	*padma*	*mahāvṛnda*	*mahāvṛnda*
10^{32}	*mahāpadma*	*padma*	*padma*
10^{37}	–	*mahāpadma*	*mahāpadma*
10^{42}	–	*kharva*	*kharva*
10^{47}	–	*samudra*	*mahākharva*
10^{50}	–	–	*samudra*
10^{52}	–	*mahaugha*	–
10^{55}	–	–	*ogha*
10^{60}	–	–	*mahaugha*

Abbreviations: Lahore = Lahole edition, Yuddhakhāṇḍa, sarga 4, 51–53; Baroda = Baroda edition, Yuddhakhāṇḍa, sarga 4, extra verses; Bombay/Gorakhpur = Bombay/Gorakhpur edition, Yuddhakhāṇḍa, sarga 4, 33–38.

Table 6.6: Names of Decimal Places in the *Vāyupurāṇa*

	VP1	VP2		VP1	VP2
10^0	*eka*	⟨*eka*⟩	10^9	*abja*	*svarbuda*
10^1	*daśa*	⟨*daśa*⟩	10^{10}	*kharva*	*kharva*
10^2	*śata*	*śata*	10^{11}	*nikharva*	*nikharva*
10^3	*sahasra*	*sahasra*	10^{12}	*śaṅku*	*śaṅku*
10^4	*ayuta*	*ayuta*	10^{13}	?	*padma*
10^5	*niyuta*	*niyuta*	10^{14}	*samudra/madhya*[45]	*samudra*
					to be continued

44 This table has been constructed according to Ganitanand 1990, 10–16.

45 The text must be corrupt here (VP 101.97–99ab); probably a hemistich giving a term (*mahāpadma*?) for the fourteenth decimal place is missing.

> *śataṃ koṭisahasrāṇāṃ śaṅkur ity abhidhīyate,*
> ⟨*lacuna?*⟩
> *sahasraṃ tu sahasrāṇāṃ koṭīnāṃ daśadhā punaḥ,*
> *guṇitāni samudraṃ vai prāhuḥ saṃkhyāvido janāḥ //97//*
> *koṭīnāṃ sahasram ayutam ity ayaṃ madhya ucyate,*
> *koṭisahasraniyutā sa cānta iti saṃjñitaḥ //98//*
> *koṭikoṭisahasrāṇi parārdha iti kīrtyate //99ab//*

Hundred of thousand *koṭi* is called *śaṅku*. ⟨. . .⟩ is thousand of thousand *koṭi*, and, when multiplied by ten, it is called *samudra* by the people who know numbers. Thousand *ayuta* of *koṭi* is the same, and ⟨also⟩ called *madhya*. Thousand *niyuta* of *koṭi* is named *anta*. Thousand *koṭi* of *koṭi* is called *parārdha*.

Names of Decimal Places in the *Vāyupurāṇa* (*continued*)

10^6	?	*prayuta*	10^{15}	*anta*	*madhyama*
10^7	*arbuda/koṭi*	*arbuda*	10^{16}	?	*parārdha*
10^8	⟨*ny*⟩*arbuda*[46]	*nyarbuda*	10^{17}	*parārdha*	*apara*[47]
			2×10^{17}	*para*[48]	–

Abbreviations: VP1 = *Vāyupurāṇa* 101.93–99; VP2 = *Vāyupurāṇa* 101.100–102.

Table 6.7: Names of Decimal Places in the Eleventh Century[49]

	Bhoja	Bīrūnī	Kṣīrasvāmin
10^0	*eka*	*eka*	*eka*
10^1	*daśa*	*daśa*	*daśa*
10^2	*śata*	*śata*	*śata*
10^3	*sahasra*	*sahasra*	*sahasra*
10^4	*ayuta*	*ayuta*	*ayuta*
10^5	*niyuta*	*lakṣa*	*prayuta/lakṣa*
10^6	*prayuta*	*prayuta*	*niyuta*
10^7	*arbuda*	*koṭi*	*arbuda/koṭi*
10^8	*nyarbuda*	*nyarbuda*	*nyarbuda*
10^9	*vṛnda*	*padma*	*padma*
10^{10}	*kharva*	*kharva*	*kharva*
10^{11}	*nikharva*	*nikharva*	*nikharva*
10^{12}	*śaṅku*	*mahāpadma*	*mahābja*
10^{13}	*padma*	*śaṅku*	*śaṅku*
10^{14}	*amburāśi*	*samudra*	*samudra*
10^{15}	*madhya*	*madhya*	*madhya*
10^{16}	*antya*	*antya*	*antya*
10^{17}	*para*	*parārdha*	*parārdha*
10^{18}	*apara*	–	–
10^{19}	*parārdha*	–	–

Abbreviations: Bhoja = *Samarāṅgaṇasūtradhāra* 9.47cd–50ab; Bīrūnī = al-Bīrūnī's *India*, trans., Part 1, p. 175; Kṣīrasvāmin = *Amarakośodghāṭana* on *Amarakośa* 2.9.84cd.

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46 The text must be corrupt here also (VP 101.95). After defining *niyuta*, it reads:

> *tathā śatasahasrāṇām arbudaṃ koṭir ucyate,*
> *arbudaṃ daśakoṭyas tu abjaṃ koṭiśataṃ viduḥ //95//*

Probably we have to correct *tathā* to *śataṃ*, and the second *arbudaṃ* to *nyarbudaṃ* (cf. Table 6.7, Kṣīrasvāmin).

> Hundred of hundred thousand is *arbuda*, and it is ⟨also⟩ called *koṭi*. Ten *koṭi* is *nyarbuda* and, it is known, hundred *koṭi* is *abja*.

47 VP 101.102cd explicitly refers to 'these eighteen places' (*aṣṭādaśaitāni sthānāni*).

48 The interpretation that *parārdha* is half (*ardha*) of *para* is referred to by al-Bīrūnī in connection with a day of God. See his *India*, trans., Part 1, p. 175.

49 Cf. GT (ca. A.D. 1039/56) in Table 6.2.

6.4 pada

The word *pada* used in mathematical contexts usually means one of the following:

1. A measure of length and area.
2. Any one in a group of numbers (or of numerical figures).
3. The number of terms in a finite mathematical series.
4. The square root.
5. A quarter (= *pāda*).

The third and fifth meanings occur in the BM. The absence of the fourth meaning from the BM will be discussed below. Now, a question arises: In what sense is the word *pada* employed in the following passage?

yasya padaṃ na jñāyate ta⟨... (lost) ...⟩ *dīnārai. yā* $\frac{1}{1}$. (II 4)

None of the above five meanings seems to fit in this context. The only meaning I can suggest is 'the value,' although such a meaning has not been attested in any other Sanskrit works. Thus, the passage may be tentatively translated:

The ⟨quantity⟩ whose value is not known is ⟨called *yāvattāvat*. ...⟩ in *dīnāras*. *yā* $\frac{1}{1}$.

The meaning, 'value,' however, could be indicated by the common word *dhana*. I suspect that the peculiar usage of the word *pada* may have been caused by the author's misunderstanding. Compare the following two passages of the anonymous commentary on the *Pāṭīgaṇita*.

iha hi padaṃ na jñāyate. atas tad avyaktam iti saṃjñāyate.[50]

Here indeed the period is not known. Therefore, it is technically called non-manifest.

tatra padaṃ na jñāyata iti yāvattāvatā dhanam ānīyate.[51]

The period thereof is not known. So, by ⟨taking it to be⟩ *yāvattāvat*, the sum ⟨of the series⟩ is calculated.

In these passages, the word *pada* means the number of terms in a finite mathematical series.

The BM is conspicuous by the absence of the term *pada* meaning the square root. In the extant portion of the work, the square root is denoted nine times by *mūla*, and twice by *karaṇī*, but never by *pada*. The same phenomenon occurs in the *Āryabhaṭīya* (A.D. 499), which uses the word *mūla* twelve times in the sense of the square root,[52] and twice in the sense of the cubic root,[53] but which never employs *pada* in either of those senses.

As has been pointed out by Datta and Singh, the term *pada* meaning the square root or cubic root seems to have come into use in relatively later times, although their statement, 'it occurs first in the work of Brahmagupta (A.D. 628),' is wrong.[54] Actually, in the *Pañcasiddhāntikā* (ca. A.D. 550), we find 13 instances of *pada* used in the sense of the square root, and 17 instances of *mūla* in the same sense. Presumably, the word *pada* began to be used in that sense in Sanskrit

50 Anon. comm. on *Pāṭīgaṇita* 87 (p. 121).
51 Anon. comm. on *Pāṭīgaṇita* 112 (pp. 143–144).
52 *Āryabhaṭīya* 2.4; 2.7; etc.
53 *Āryabhaṭīya* 2.5 and 2.21.
54 Datta and Singh 1935/38, Part 1, p. 170.

works after Āryabhaṭa and before Varāhamihira, but we have too little material to substantiate this conjecture.[55]

Table 6.8 shows the statistics of *mūla* and *pada*, which cannot be called exhaustive, but which reveals an interesting fact, that is, Śrīdhara's unusual preference of *mūla* instead of *pada*, especially in his *Triśatikā*.

Table 6.8: Frequency of *mūla* and *pada* in Sanskrit Mathematical Works[56]

Skt. works	*mūla*	*pada*	Total	$\frac{pada}{\text{total}} \times 100(\%)$
BM	9	0	9	0
AB	14	0	14	0
PS	17	13	30	43
BSS 12	8	12	20	60
BSS 18	12	19	31	61
Tr	21	2[57]	23	9
PG	26	10	36	28
GSS	92	49	141	35
MS 15	25	14	39	36
GT	30	17	47	36
SS 13	10	13	23	57
SS 14	13	8	21	38
L	26	21	47	45
BG	46	45	91	49

Abbreviations: BM = *Bakhshālī Manuscript* (incomplete); AB = *Āryabhaṭīya*; PS = *Pañcasiddhāntikā*; BSS 12 = *Brāhmasphuṭasiddhānta* Chap. 12 (*gaṇita*); BSS 18 = *Brāhmasphuṭasiddhānta* Chap. 18 (*kuṭṭaka*); Tr = *Triśatikā* (on *pāṭī*); PG = *Pāṭīgaṇita* (on *pāṭī*, incomplete); GSS = *Gaṇitasārasaṃgraha* (on *pāṭī*); MS 15 = *Mahāsiddhānta* Chap. 15 (on *pāṭī*); GT = *Gaṇitatilaka* (on *pāṭī*, incomplete); SS 13 = *Siddhāntaśekhara* Chap. 13 (on *vyakta-gaṇita*); SS 14 = *Siddhāntaśekhara* Chap. 14 (on *avyakta-gaṇita*); L = *Līlāvatī* (on *pāṭī*); BG = *Bījagaṇita* of Bhāskara.

6.5 pratyaya, pratyānayana, and upapatti

The word *pratyaya* meaning a verification of the answer to a mathematical problem very often occurs in our text (see Index). The word *pratyānayana* ('bringing back' or 'restoration') is also used several times in the same sense. The word *upapatti* ('proof') never occurs in the BM, but it is worthy of notice in connection with *pratyaya*.

55 For further information about *mūla* and *pada*, see Datta 1927 and 1931.

56 The prose parts of the works are excluded from this survey, since they are apt to be changed in the course of transmission.

57 These two cases occur in mensuration formulas (Tr 43 and 54).

6.5.1 pratyaya and pratyānayana

It is easy to understand the derivation of the meaning, 'a verification,' of *pratyānayana* from its original meanings, but I have not found the word used in that sense in any other mathematical work.

The word *pratyaya* is given different technical meanings by different people (for example, 'a suffix' by native Sanskrit grammarians, 'the co-operative cause' by the Buddhists, etc.); but 'a verification' or 'a proof' seems to have been one of the ordinary meanings of the word in Sanskrit literature. For example, when Sītā, wife of Rāma, was rescued from the hands of Rāvaṇa,

> *pratyayārthaṃ tataḥ sītā viveśa jvalanaṃ tadā.*[58]
>
> then, in order to prove ⟨her chastity⟩, Sītā jumped into the fire at that time.

Sanskrit dictionaries record *pratyaya* used in the sense of a proof or ascertainment in the *Mahābhārata*, *Manusmṛti*, etc.

In mathematics, the word first occurs, as far as I know, in the elder Bhāskara's commentary on the *Āryabhaṭīya* in the form *pratyayakaraṇa*.[59] A mensuration rule of Āryabhaṭa reads thus:

> *sarveṣāṃ kṣetrāṇāṃ prasādhya pārśve phalaṃ tadabhyāsaḥ.*[60]
>
> Of all plane figures, when one has determined two sides ⟨orthogonal to each other⟩, their product is the area (lit. fruit).

This amounts to saying that the area of any plane figure can be regarded as the product of two lengths: the area of a triangle as the product of the base and half the height, that of a circle as the product of the radius and half the circumference, etc. According to Bhāskara, however, this rule is meant not only for the interpretation of the area but also for the verification of those obtained by means of other methods.

> *pratyayakaraṇaṃ phalaṃ cānenocyate. abhihitānāṃ kṣetrāṇāṃ phalasya pratyayakaraṇam.*[61]
>
> Verification and the area are meant by this ⟨rule⟩. For the figures stated, verification of the area ⟨is meant by the rule⟩.

When Bhāskara illustrates the above rule with examples, he states:

> *pūrvasūtraniṣpannakṣetraphalānāṃ pratyayakaraṇaṃ pradarśyate. tad yathā—*
>
> > *tricaturbhujavṛttānāṃ dṛṣṭāni yāni gaṇitena,*
> > *teṣāṃ pratyayakaraṇaṃ kathaya kathaṃ bhavati sarveṣām.*[62]
>
> The verification of the areas produced by means of the preceding rules is shown. So is it said: 'Say how the verification is made of all the areas of triangles, quadrilaterals, and circles, which have been determined by means of the mathematics ⟨of Āryabhaṭa⟩.'

The following statement of Bhāskara testifies to the fact that there existed in India before him (A.D. 629) people who were not only interested in the verification of answers, but also expressly declared its importance.

58 *Rāmāyaṇa* 7.45.7ab.
59 Note the prallelism in: *yāva* of the BM and *yāvakaraṇa* of Bhāskara. See Sec. 6.7 below.
60 *Āryabhaṭīya* 2.9ab.
61 Bhāskara, *bhāṣya* on *Āryabhaṭīya* 2.9ab (p. 67).
62 Bhāskara, *bhāṣya* on *Āryabhaṭīya* 2.9ab (p. 68).

gaṇitavido maskarīpūraṇapūtanādayaḥ sarveṣāṃ kṣetrāṇāṃ phalam āyatacaturaśra-kṣetre pratyāyayanti. uktaṃ ca—

karaṇair uktair nityaṃ phalam anugamyāyate tu vijñeyam,
pratyayakaraṇaṃ kṣetre vyaktaṃ phalam āyate yasmāt.[63]

The mathematicians, Maskarī, Pūraṇa, Pūtana, etc. prescribe the verification of all ⟨plane⟩ figures ⟨by transforming them⟩ into a rectangular figure. So has it been said: 'Having determined the area in accordance with the prescribed rule, verification should always be made by ⟨transforming the plane figure into⟩ a rectangle, because it is only of the rectangle that the area is obvious.'[64]

Of course, the verification (*pratyayakaraṇa*) of Bhāskara is not limited to the area. When he has solved an example by means of the rule given in *Āryabhaṭīya* 2.17cd:

$$\left(\frac{a}{2}\right)^2 = b(d-b),$$

where a and b are respectively the chord and versed sine of a segment of a circle whose diameter is d, he suggests the verification by means of the Pythagorean theorem, that is given in *Āryabhaṭīya* 2.17ab.

He also gives a verification of the answer to an example for *Āryabhaṭīya* 2.25 (on compound interest) by using the *pañcarāśika* ('rule of five' or compound rule of three). His style there very much resembles that of the BM.

pratyayakaraṇaṃ pañcarāśikena—yadi śatasya māsikī vṛddhiḥ pañca tadā caturbhir māsaiḥ śatavṛddheḥ kā vṛddhir iti. nyāsaḥ $\begin{smallmatrix}1 & 4\\ 100 & 5\\ 5 & 0\end{smallmatrix}$ *labdhaṃ* 1. *etatsahitā śatavṛddhiḥ ṣaḍrūpāṇi* 6.[65]

Verification by means of the rule of five: If the monthly interest on one hundred is five, what is the interest on the interest on one hundred for four months? Statement: $\begin{smallmatrix}1 & 4\\ 100 & 5\\ 5 & 0\end{smallmatrix}$ Obtained is 1. This, increased by the interest on one hundred, is six *rūpas*: 6.

Śrīdhara, in his *Triśatikā* 1 and 2, prescribes two alternative formulas for obtaining the sum of the first n terms of the natural series:

$$S = \frac{n(n+1)}{2} = \frac{n^2+n}{2},$$

and remarks:

yat saṅkalite 'nyatkaraṇasūtram uktaṃ tat pṛthagaṅkayojanāvāptavittasya pratyayā-rthaṃ laghukarmārthaṃ ca.[66]

In the summation of the natural series, an additional rule was told. This is for the sake of verification of the sum obtained by adding the numbers one by one ⟨on the one hand⟩, and for easy calculation ⟨on the other hand⟩.

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63 Bhāskara, *bhāṣya* on *Āryabhaṭīya* 2.9ab (p. 67). In the text, this comes immediately after the first citation.
64 Trans. by Shukla and Sarma 1976, 44.
65 Bhāskara, *bhāṣya* on *Āryabhaṭīya* 2.25 (pp. 114–115).
66 Śrīdhara, *Triśatikā* Ex. 2 (in the prose part).

The anonymous commentator on Śrīdhara's *Pāṭīgaṇita* gives a verification (*pratyaya*) of the answer to an example for '*ekapatrīkaraṇa*' or the conversion of several bonds into one by using the *pañcarāśika*.[67] He also verifies several examples in the chapter on mathematical series, although there he does not use the term *pratyaya*.[68]

Verification is very rarely given in later mathematical texts except in Siṃhatilaka Sūri's commentary (ca. A.D. 1269) on Śrīpati's *Gaṇitatilaka*; verification there is called *ghaṭanā*,[69] which literally means 'joining or union,' or 'accomplishment.'

6.5.2 upapatti

While the term *pratyaya* (or *pratyayakaraṇa* of the elder Bhāskara) denotes the verification of the answer to a mathematical problem, the term *upapatti* stands for the proof or derivation of a mathematical formula. We find a number of instances of *upapatti* used in that sense in later commentaries such as Gaṇeśa's *Buddhivilāsinī* (A.D. 1545) on the *Līlāvatī* and Kṛṣṇa's *Navāṅkura* (ca. A.D. 1600) on the *Bījagaṇita*. As far as is known, its first occurence is again in the elder Bhāskara's commentary on the *Āryabhaṭīya*.

On supporting Āryabhaṭa's value of π, $\frac{62832}{20000}$, Bhāskara criticizes the so-called Jaina value of π used in the formula: $c = \sqrt{10d^2}$.

> *atrāpi kevala evāgamo naivopapattiḥ. rūpaviṣkambhasya daśakaraṇyaḥ paridhir iti. atha manyate pratyakṣeṇaiva pramīyamāṇo rūpaviṣkambhakṣetrasya paridhir daśakaraṇya iti. naitat. aparibhāṣitapramāṇatvāt karaṇīnām. ekatrivistārāyāmāyatacaturaśrakṣetrakarṇena daśakaraṇikenaiva tadviṣkambhaparidhir veṣṭyamāṇaḥ sa tatpramāṇo bhavatīti cet tad api sādhyam eva.*[70]

> Here also, there is only a tradition (*āgama*), and not a proof (*upapatti*), that the circumference of ⟨a circle⟩ whose diameter is unity is the square root of ten. ⟨The opponents may declare:⟩ 'It is construed that the circumference of a ⟨circular⟩ figure whose diameter is unity, when measured by means of the direct perception (*pratyakṣa*), is the square root of ten (*daśakaraṇī*).' That is wrong, because the magnitude of *karaṇīs* cannot be stated exactly. They may further argue: 'When the circumference for that (unit) diameter is enclosed with the diagonal of a rectangle whose breadth and length are one and three ⟨respectively⟩, i.e., with ⟨the line measured by⟩ the square root of ten, it (the circumference) has that length.' But that too has to be established.

For the word *karaṇī* used in the above passage, see Sec. 6.2 above. In one place of the same commentary, he uses the term *upapatti* in the sense of the reason or ground on which a particular *trairāśika* (rule of three) is based:

> ... *iti trairāśikopapattidarśanārthaṃ kṣetranyāsaḥ*.[71]

> Statement of a plane figure in order to show the ground of the *trairāśika* that ...

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67 *Pāṭīgaṇita* Ex. 59.
68 *Pāṭīgaṇita* Exs. 111 and 112.
69 Siṃhatilaka Sūri, *vṛtti*, p. 43, et passim.
70 Bhāskara, *bhāṣya* on *Āryabhaṭīya* 2.10 (p. 72).
71 Bhāskara, *bhāṣya* on *Āryabhaṭīya* 2.6cd (p. 59).

As a matter of fact, however, we can hardly find proofs or derivations of mathematical rules in Bhāskara's commentary on the *Āryabhaṭīya*.

The anonymous commentator on the *Pāṭīgaṇita* gives an *upapatti* of Śrīdhara's algorithm for obtaining the period of an arithmetical progression:[72]

$$n = \frac{\sqrt{8dS + (2a-d)^2} - 2a + d}{2d}.$$

The commentator begins his *upapatti* with the following statement:

> *kātropapattir iti ced ucyate. sarvāṇīmāni karaṇasūtrāṇi yuktibījamūlāni. yuktimūlaṃ yathā saṅkalitaṃ darśitam. vargādimūlāni bījamūlāni tathedam eva saṅkalitamūlānayanam. iha hi padaṃ na jñāyate. atas tad avyaktam iti saṃjñāyate. etadīyapramāṇasya cāniyatatvād yāvattāvad iti vyavahāraḥ. gaṇitakarmaṇy api yāvattāvacchabdādyakṣareṇa yā ity anenāsyopalakṣaṇaṃ bhavati.*[73]
>
> What is the *upapatti* of this ⟨formula⟩? It is told ⟨thus⟩. All these computational rules (*karaṇasūtrāṇi*) are based either on reasoning (*yukti*) or on seeds (*bījāni*, i.e., equations). What is based on reasoning is, for example, the sum of the arithmetical progression, which has already been shown. The roots of square numbers etc. are based on seeds, and so also is this computation of the period of an arithmetical progression. Here indeed the period is not knwon. Therefore, it is termed non-manifest (*avyakta*). Since such a quantity has the state of being indefinite (*aniyata*), it is commonly called *yāvattāvat* ('as much as'). In mathematical computation also, it is symbolically expressed (*upalakṣaṇa*) as *yā*, which is the first letter of the word *yāvattāvat.*

The *upapatti* given by the commentator is interesting as it clearly illustrates how medieval Indian mathematicians utilized algebraic symbolism in deriving some of their algorithms. Since they did not know algebraic symbols for known numbers, the derivation of a formula was based on a concrete example with known numbers. In the present case, the commentator bases his argument on the progression whose first term and common difference are 2 and 3 respectively; its sum up to the 5th term is 40: $a = 2$, $d = 3$, $n = 5$, and $S = 40$. As we have seen above, he assumes that n is unknown, and expresses it as '*yā* 1' with the coefficient 1. Let us denote it by x for convenience. Then his argument goes thus. By means of the formula for the sum of an arithmetical progression:[74]

$$S = \left\{\frac{3(x-\underline{1})}{\underline{2}} + 2\right\} x = \frac{3}{\underline{2}}x^2 + \left(\frac{\underline{2}\cdot 2 - 3}{\underline{2}}\right) x = 40,$$

where the underlines indicate invariable factors. Therefore,

$$3x^2 + (\underline{2}\cdot 2 - 3)x = \underline{2}\cdot 40.$$

Here, the commentator cites from an unknown source one and a half Śloka stanzas that prescribe the formula:[75]

$$x = \frac{\sqrt{4ac - b^2} - b}{2a},$$

72 Śrīdhara, *Pāṭīgaṇita* 87. Cf. Sūtra N18 of the BM.

73 Anon. comm. on *Pāṭīgaṇita* 87 (pp. 120–121).

74 *Pāṭīgaṇita* 85.

75 Cf. *Brāhmasphuṭasiddhānta* 18.44–45; *Siddhāntaśekhara* 14.17–19; and *Bījagaṇita* 115–116.

when $ax^2 + bx = c$. This formula solves the above quadratic equation:

$$\begin{aligned} x &= \frac{\sqrt{\underline{4} \cdot 3 \cdot (\underline{2} \cdot 40) + (\underline{2} \cdot 2 - 3)^2} - (\underline{2} \cdot 2 - 3)}{\underline{2} \cdot 3} \\ &= \frac{\sqrt{\underline{8} \cdot 3 \cdot 40 + (\underline{2} \cdot 2 - 3)^2} - \underline{2} \cdot 2 + 3}{\underline{2} \cdot 3} \\ &= 5 = n. \end{aligned}$$

Thus we have Śrīdhara's formula cited above, which had to be expressed only verbally in the days when algebraic symbolism was not developed enough. The above method, however, may not have been as cumbersome to the ancients, who must have familiarized themselves with the differentiation between variables and invariables in equations, as to the moderns, who have got accustomed to symbols for known values.

6.6 yā = yāvattāvat

The abbreviation *yā* of *yāvattāvat*, the most popular symbol for the unknown quantity in *bījagaṇita* ('mathematics of seeds' or algebra), occurs in the BM (II 4, Ex. 3 for Sūtra N6). Kaye correctly transliterated the letter *yā* accompanied by its coefficient '$\frac{1}{1}$' in his first text,[76] but, as he failed to understand its meaning,[77] he omitted it in his rearranged text.[78] This seems to have led B. Datta, who relied on Kaye's study, to his erroneous statements about several important points regarding the characteristics of the BM.[79]

The symbol *yā* is, in the BM (Ex. 3 for Sūtra N6), used in a restricted sense: its role there is only to reduce the given relations between three unknowns to the standard form to which the rule (Sūtra N6) can be applied mechanically. Thus, once the standard form is obtained (II 5), the symbol *yā* is discarded, and the rule is employed to solve the problem.

The reduction to the standard form in the present case would be difficult, if not impossible, without using algebraic symbolism. This is an important point for understanding the true nature of the BM. Works on *pāṭī* or algorithm such as Śrīdhara's *Triśatikā* and *Pāṭīgaṇita*, Mahāvīra's *Gaṇitasārasaṃgraha*, Śrīpati's *Gaṇitatilaka*, Bhāskara's *Līlāvatī*, and Nārāyaṇa's *Gaṇitakaumudī*, just like the BM, consist of rules and examples, but in those works most examples are given in such a way that they can be easily solved by mechanical applications of the prescribed rules. The above instance of the use of *yā* suggests that the BM did not have such a scheme.[80]

The first definite testimony, as far as I know, for the term *yāvattāvat* in the sense of the unknown quantity is found in the elder Bhāskara's commentary on the *Āryabhaṭīya*. Āryabhaṭa's rule for solving linear equations with one unknown runs thus:

> *gulikāntareṇa vibhajed dvayoḥ puruṣayos tu rūpakaviśeṣam,*
> *labdhaṃ gulikāmūlyaṃ yady arthakṛtaṃ bhavati tulyam.*[81]

One should divide the difference of *rūpakas* by the difference of *gulikās*, of the two

76 Kaye 1927/33, 145.
77 Kaye 1927/33, 33: 'There is no algebraic symbolism in our text.'
78 Kaye 1927/33, 162.
79 Datta 1929a, 24, 38, and 56.
80 Cf. Chapter 7 below.
81 *Āryabhaṭīya* 2.30. Cf. Sūtra 51 of the BM.

persons. The quotient is the price of the *gulikā* if ⟨their properties, when⟩ reduced to money, are the same.

That is, the equation,

$$ax + b = cx + d,$$

where x = *gulikāmūlya* ('the price of a bead'), a and c = *gulikā* ('the ⟨number of⟩ beads'), and b and d = *rūpaka* ('the ⟨number of⟩ coins'), can be solved by:

$$x = \frac{d-b}{a-c}.$$

Bhāskara, having explained two examples for this rule, continues:

> *et⟨a⟩ eva gulikā ajñātapramāṇā yāvattāvanta ucyante. rūpakā eva tatrāpi. yāvattāvatsaṃjñayāpy uddeśakā abhidhīyante. tad yathā — sapta yāvattāvat sapta ca rūpakāḥ samā dvayor yāvattāvator dvādaśānāṃ ⟨ca⟩ rūpakānām. kiyanto yāvattāvatpramāṇāḥ.* 3.
>
> *nyāsaḥ* $\begin{matrix}7 & 7\\ 2 & 12\end{matrix}$
>
> *karaṇam. pūrvavad gulikānāṃ yāvattāvatāṃ viśeṣa upariśuddhe* 5. *adhaḥśuddhe rūpakaviśeṣaḥ* 5. *yāvattāvadviśeṣeṇa rūpakaviśeṣasya bhāgalabdhaṃ yāvattāvatpramāṇam* 1. *etena yāvattāvatpramāṇena yāvattāvanto gulikā jātāḥ krameṇa* 7, 2. *svān svān rūpān prakṣipya samāḥ. prathamasya* 14. *dvitīyasya tad eva* 14.[82]
>
> These beads (*gulikā*), whose value is unknown, are ⟨otherwise⟩ called *yāvattāvat* ('as much as'). There too, the term coins (*rūpaka*) is the same. Examples are told also by using the term *yāvattāvat*. Thus, for example:
>
> Seven *yāvattāvats* and seven coins together are equal to the sum of two *yāvattāvats* and twelve coins. How much is the value of ⟨each of⟩ the *yāvattāvats*? ⟨Example⟩ 3.
>
> Statement: $\begin{matrix}7 & 7\\ 2 & 12\end{matrix}$
>
> Computation. The difference of *gulikās*, i.e., of the *yāvattāvats*, is ⟨calculated⟩ as before. ⟨The lower⟩ being subtracted from the upper, ⟨the result is⟩ 5. ⟨The upper⟩ being subtracted from the lower, the difference of the coins is 5. The quotient from the division of the difference of the coins by the difference of the *yāvattāvats* is the value of the *yāvattāvat*, i.e., 1.
>
> By means of this value of the *yāvattāvat*, the *yāvattāvats* or beads ⟨on the two sides of the equation⟩ become 7 and 2 respectively. When one has added their respective coins, ⟨the two sides become⟩ equal ⟨to each other, that is,⟩ 14 for the first, and the same 14 for the second.

Note that a later mathematician would naturally write down the 'Statement' as: $\begin{matrix}\textit{yā}\ 7 & \textit{rū}\ 7\\ \textit{yā}\ 2 & \textit{rū}\ 12\end{matrix}$. This may indicate that Bhāskara did not know the use of the abbreviated symbol '*yā*'. Also note, in passing, the resemblance between Bhāskara's style of exposition and that of the BM: an example (here called *uddeśaka*), statement (*nyāsa*), computation (*karaṇa*), and a verification (no designation here).

In another place, Bhāskara refers to the *yāvattāvat* as one of four 'seeds' (*bījāni*) which generate the eight kinds of *vyavahārāḥ* (practical problems):

---

82 Bhāskara, *bhāṣya* on *Āryabhaṭīya* 2.30 (p. 128).

... *iti vyavahāraganitasyāṣṭābhidhāyinaś catvāri bījāni prathamadvitīyatṛtīyacaturthāni yāvattāvadvargāvargaghanāghanaviṣamāṇi. etadekaikasya granthalakṣaṇalakṣyaṃ maskarīpūraṇamudgalaprabhṛtibhir ācāryair nibaddhaṃ kṛtam.*[83]

The arithmetic of *vyavahārāḥ* bearing the eight-fold name as stated has four seeds (*bījāni*), that is, the first, second, third, and fourth, ⟨otherwise called⟩ *yāvattāvat* ('as much as'), *vargāvarga* ('square and non-square'?), *ghanāghana* ('cube and non-cube'?), and *viṣama* ('odd'). For each of these, a treatise consisting of rules (*lakṣaṇa*)[84] and examples (*lakṣya*) has been composed by the teachers Maskarī, Pūraṇa, Mudgala, and others.

We may infer from the above usage of the term that the 'first seed' called *yāvattāvat* signifies simple equations with one unknown, but what are intended by the other names are not very clear to me. K. S. Shukla interprets the 'four seeds' as methods for solving simple equations, quadratic equations, cubic equations, and equations with more than one unknown.[85]

The passage just cited from Bhāskara is important for the history of Indian mathematics, especially of *bījagaṇita* ('mathematics of seeds'). For it shows that the concept of 'four seeds' already existed in, and even before, the time of the elder Bhāskara (A.D. 629), although they do not seem to have been exactly the same as those of later mathematicians. According to an anonymous commentator on Chapter 18 of the *Brāhmasphuṭasiddhānta*, the 'four seeds' are:[86]

1. *ekavarṇasamīkaraṇa* or equations with one color, i.e., with one unknown.
2. *madhyamāharaṇa* or elimination of the middle term, i.e., solution of quadratic equations.
3. *anekavarṇasamīkaraṇa* or equations with more than one color.
4. *bhāvitakasamīkaraṇa* or equations of the 'produced', i.e., of the type: $axy = bx + cy + d$.

These constitute the main part of the younger Bhāskara's *Bījagaṇita* (A.D. 1150), the chapters of which may be divided as follows.

1. Introduction[87]
   (a) *dhanarṇaṣaḍvidha* or six kinds ⟨of operations⟩[88] of positive and negative numbers.
   (b) *śūnyaṣaḍvidha* or six kinds ⟨of operations⟩ involving zero.

83 Bhāskara, *bhāṣya* on *Āryabhaṭīya* 1.1 (p. 7).

84 Cf. '*lakṣaṇāni sūtrāṇi*' and '*lakṣaṇasūtram*' in Bhāskara's *bhāṣya* on *Āryabhaṭīya* 2.3 (pp. 49 and 51).

85 Shukla 1976, liv and lxxvi. A Jaina canonical work, *Sthānāṅgasūtra* enumerates ten topics of *gaṇita* thus:

parikamma vavahāro rajju rāsī kalāsavanne ya,
jāvaṃtāvati vaggo ghano ta taha vaggavaggo vikappo ta. (Sūtra 747)

The sixth to the ninth items of this list resemble the four 'seeds' of Bhāskara. Cf. Datta 1929b, 119, for a discussion of this passage.

86 *Kuṭṭakavivaraṇa*, fols. 15b–30b.

87 The last verse of the section on *vargaprakṛti* (*Bījagaṇita* 88) reads thus:

uktaṃ bījopayogīdaṃ saṃkṣiptaṃ gaṇitaṃ kila,
ato bījaṃ pravakṣyāmi gaṇakānandakārakam.

This mathematics, which is useful for *bīja*, was truely told concisely. From now on, I shall explain *bīja*, which causes the pleasure of mathematicians.

88 They are addition, subtraction, multiplication, division, squaring, and root-extraction.

(c) *varṇaṣaḍvidha* or six kinds ⟨of operations⟩ involving colors (i.e., unknown numbers).

(d) *karaṇīṣaḍvidha* or six kinds ⟨of operations⟩ involving *karaṇīs*.[89]

(e) *kuṭṭaka* or pulverizer, i.e., a method for solving indeterminate equations of the type: $y = \frac{bx+c}{a}$.

(f) *vargaprakṛti* or square-nature, i.e., a method for solving indeterminate equations of the type: $y^2 = Nx^2 + c$.

2. *ekavarṇasamīkaraṇa*
3. *madhyamāharaṇa*
4. *anekavarṇasamīkaraṇa*
5. *madhyamāharaṇa* for the *anekavarṇasamīkaraṇa*
6. *bhāvita*
7. *granthasamāpti* or conclusion

The same four 'seeds' are treated in the same order also in Chapter 18 (*kuṭṭakādhyāya*) of the *Brāhmasphuṭasiddhānta* (A.D. 628). At the beginning of that chapter, Brahmagupta enumerates the topics treated in it:

> *kuṭṭakakharṇadhanāvyaktamadhyaharaṇaikavarṇabhāvitakaiḥ,*
> *ācāryas tantravidāṃ jñātair vargaprakṛtyā ca.*[90]
>
> The pulverizer, zero, positive and negative numbers, unknown numbers, elimination of the middle term, ⟨equaitons with⟩ one unknown, ⟨equaitons of⟩ the produced, and the square-nature having been mastered, ⟨one will become⟩ the teacher of those who knows *tantra* (mathematical doctrine).

There is, however, no strong evidence to show that Brahmagupta has the concept of 'four seeds': in that chapter, those four topics seem to have the same weight as the others. It should also be remembered that the title of that chapter is not *bījagaṇita* (mathematics of seeds) but *kuṭṭakādhyāya* (chapter on pulverizer), although almost all topics of *bījagaṇita* are included in it.[91]

It is probably significant that the term *yāvattāvat* for the unknown quantity never occurs in the *Brāhmasphuṭasiddhānta* (A.D. 628) of Brahmagupta, a contemporary of the elder Bhāskara. Brahmagupta simply calls it *avyakta* (non-manifest),[92] or otherwise *varṇa* (color);[93] he employs the latter term especially when he needs to distinguish more than one unknown.

In connection with Brahmagupta's rule for linear equations with more than one unknown,[94] the anonymous commentator remarks:

> *yatrodāharaṇe dvyādayo 'vyaktā rāśayo bhavanti tatra teṣāṃ mānāni yāvattāvadādayo varṇāḥ kalpyāḥ.*[95]

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89 See Sec. 6.2 above for *karaṇī*.

90 Brahmagupta, *Brāhmasphuṭasiddhānta* 18.2.

91 Likewise, the term *pāṭī* does not occur in the work, although its twelfth chapter called *gaṇitādhyāya* (chapter on mathematics) has almost the same topics as later works on *pāṭī*.

92 *Brāhmasphuṭasiddhānta* 18.2, 41, 43, 45, and 60.

93 *Brāhmasphuṭasiddhānta* 18.2, 42, 51, 62, and 63.

94 *Brāhmasphuṭasiddhānta* 18.51.

95 *Kuṭṭakavivaraṇa*, fol. 18a.

> In an example in which there are two or more unknown quantities, two or more colors, as *yāvattāvat*, etc., must be put for their values.[96]

The commentator, in solving a system of linear equations, uses besides the initial letter of *yāvattāvat* those of *kālaka* (black), *nīlaka* (blue), *pīta* (yellow), *lohita* (red), and *harita* (green).[97] He is, however, wrong in including *yāvattāvat* ('as much as') in 'colors.' The same terminology is more properly set forth by the younger Bhāskara:

> *yāvattāvat kālako nīlako 'nyo varṇaḥ pīto lohitaś caitadādyāḥ,*
> *avyaktānāṃ kalpitā mānasaṃjñās tatsaṃkhyānaṃ kartum ācāryavaraiḥ.*[98]
>
> 'So much as' and the colours 'black, blue, yellow, and red,' and others besides these, have been selected by venerable teachers for the purpose of reckoning therewith.[99]

The origins of these terms for unknowns are yet to be investigated, but I am inclined to conjecture that originally the 'colors' belonged to one tradition, and the *yāvattāvat* to another.[100] The 'colors' may have been related to Āryabhaṭa's *gulikās* (beads).

6.7 yāva

The term *yāva* is given as a synonym of *varga* ('square') in the passage: *vargaṃ yāva varjaye* (VII 3). This is no doubt the same *yāva* that occurs in the word *yāvakaraṇa* that is given by the elder Bhāskara as a synonym of *varga*:

> *vargaḥ karaṇī kṛtir vargaṇā yāvakaraṇam iti paryāyāḥ.*[101]
>
> ⟨The terms⟩ *varga, karaṇī, kṛti, vargaṇā*, and *yāvakaraṇa* are synonymous.

K. S. Shukla thinks that this *yāva* is the abbreviation of *yāvattāvad-varga*, a popular symbol for the square power (*varga*) of the unknown quantity (*yāvattāvat*) in *bījagaṇita*.[102] Several difficulties are, however, observed in his theory. First, there is no positive evidence to show that that particular abbreviation, *yāva* = *yāvattāvad-varga*, existed in, or before, the time of Bhāskara. On the contrary, Bhāskara does not use the symbol *yā* for *yāvattāvat* in a place where it is naturally expected.[103] Second, it seems to me to be difficult to derive the meaning 'the square of any quantity whatever' from 'the square of a certain unknown quantity.' Third, if *yāva* itself originally had the meaning 'square,' what was the purpose of making the compound *yāvakaraṇa*? Fourth, why did it disappear from the Indian mathematical scene after Bhāskara (except, for the sake of argument, in the BM)?

Now, it is most probable, as Shukla has pointed out, that the term *yāvakaraṇa* was handed down to Bhāskara by a tradition, as it is not used even by Bhāskara himself anywhere else in his commentary. This as well as the term itself remind me of the phrase *tāvatkṛtvas-kṛ*, meaning to square, which has been recorded in Sanskrit dictionaries.[104] And this latter further reminds of *yāvat ... tāvat-kṛ* used with *varga* in the *Śulbasūtras*.

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96 Trans. by Colebrooke 1817, 348, fn. 1.
97 *Kuṭṭakavivaraṇa*, fol. 24a.
98 Bhāskara, *Bījagaṇita* 21.
99 Trans. by Colebrooke 1817, 139.
100 For several attempts made in this regard, see Kaye 1915, 24–25; Ganguly 1927, 73–74; Datta 1929a, 26–28 and 59–60, and 1929b, 122–123.
101 Bhāskara, *bhāṣya* on *Āryabhaṭīya* 2.3.
102 Shukla 1976, lxxvii–lxxviii.
103 See Sec. 6.6 above.
104 Cf. Piṅgala, *Chandaḥsūtra* 5.3:

> *yāvatpramāṇā rajjus tāvatas tāvato vargān karoti.*[105]
>
> As many measures (units of some measures) as a cord contains, so many troops or rows (of small squares) it produces (when a square is drawn on it).[106]

This is the passage that was cited by G. Thibaut as illustrating the origin of the term *varga* meaning 'the square.'

It seems to me that *yāvakaraṇa* of Bhāskara is a corruption of *yāvatkaraṇa*, and that *yāva* of the BM is its abbreviated form.[107] The term *yāva* thus formed would have been discarded, as symbolic algebra, *bījagaṇita*, was developing about the time of Bhāskara, in order to avoid confusion with the symbolic expression *yāva* of *yāvattāvad-varga.*

6.8 varga and vartya

6.8.1 varga

The word *varga*, a common term for the square power, is also used in the sense of multiplication in our text (IV 5 and 6). Certainly such a meaning of the word has not been attested in any other Sanskrit works, but it cannot be otherwise interpreted. It occurs in the following passages:

1. *tadā vargaṃ tu kārayet.*
2. *eṣa vargakramagaṇitaṃ.*
3. *atha yutivargaṃ kṛyate.*
4. *eṣa yutivargagaṇitaṃ.*

B. Datta, following Hoernle, takes this *varga* to mean 'a series.'[108] But this interpretation makes it difficult to understand the second passage, in which the word *krama* also means 'a sequence' or 'a series.' On the other hand, the meaning 'multiplication' fits well in all cases (see my translation). I suspect that this *varga* is an abbreviated form either of *saṃvarga* or of *vargaṇā.*

The word *saṃvarga* meaning 'multiplication' is rarely used in Sanskrit literature, but it does occur in the *Āryabhaṭīya.*[109] For the loss of the prefix 'saṃ-', see the parallel phenomenon found in *vartya* for *apavartya* (see the next section).

The word *vargaṇā* meaning 'multiplication,' which is also very rare, occurs in *Bṛhajjātaka* 7.13: *bahuvargaṇābhiḥ*; this compound is paraphrased by the commentator Bhaṭṭotpala as *bahvībhir guṇanābhiḥ* ('on account of many multiplications'). The elder Bhāskara, however, takes *vargaṇā* to be a synonym of *varga* (the square power or squaring).[110]

> *samaṃ tāvatkṛtvaḥ kṛtam ardhasamam.*
>
> ⟨The number of⟩ 'even' ⟨stanzas⟩, repeated as many times as that (i.e., squared), is ⟨the number of⟩ 'half-even' ⟨stanzas⟩.

105 *Āpastambaśulbasūtra* 3.7.
106 Trans. by Thibaut 1875, 48 (reprint).
107 Note the parallelism in *pratyaya* (BM) and *pratyayakaraṇa* (Bhāskara). See Sec. 6.5 above.
108 Hoernle 1888, 45; Datta 1929a, 37.
109 *Āryabhaṭīya* 2.3, 6, 21, 22 (*saṃvargita*), and 23.
110 Bhāskara, *bhāṣya* on *Āryabhaṭīya* 2.3. See Sec. 6.7 above.

6.8.2 vartya

The word *vartya* occurs several times in our text (see Index), always in the sense of *apavartya* (to be reduced) < *apa-vṛt*; the regular form *apavarta* (imperative, 2nd sg.) occurs once in the text.

CHAPTER 7

Style of Exposition

The Bakhshālī work consists of versified rules (*sūtrāṇi*), examples (*udāharaṇāni*, most of them versified), and prose commentaries on the examples. A *sūtra* prescribes an algorithm or formula for solving problems of a particular type. It is followed by an example or examples to be solved by means of that *sūtra*. Under each example, the commentary gives a statement (*nyāsa/sthāpana/nyāsasthāpana*), computation (*karaṇa*), and a verification (*pratyaya/pratyānayana*) or verifications.

The 'statement' is a tabular presentation of the numerical information given in the example. The 'computation' works out the problem by following, and often citing, the *sūtra* step by step. The answer obtained is usually verified: verification either restores one of the given elements by making use of the answer, or rediscovers the same answer by following a different procedure.

Thus, the most typical pattern of exposition in the BM is:

- Rule (*sūtra*)
- Example (*udāharaṇa*)
    - Statement (*nyāsa/sthāpana/nyāsasthāpana*)
    - Computation (*karaṇa*)
    - Verification (*pratyaya/pratyānayana*)

A similar pattern is found also in Bhāskara's commentary on the chapter called *gaṇita* (mathematics) of the *Āryabhaṭīya*.[1]

There are, of course, exceptions to this typical case. Our text gives Ex. 1 for Sūtra C4 (II 9) immediately after Ex. 9 for Sūtra N6, without prescribing a *sūtra* to be applied. No examples are given for Sūtra 10, since 'the same *sūtra* has been expounded (*vivardhita*) on the second leaf (*patra*)' (III 1). The same is also the case with Sūtra 14 (III 6). No solution is given to Ex. 3 for Sūtra 15, since 'the same has been written (*abhilikhita*) also on the eleventh leaf above' (III 7).[2] Also, the answers to most examples for Sūtra C10 (the rule of three) immediately follow the 'statements' without a working process, and no verifications are given, probably because those problems are so trivial.

Most examples given in the standard works of *pāṭī* or algorithm such as Śrīdhara's *Triśatikā* and *Pāṭīgaṇita*, Bhāskara's *Līlāvatī*, etc., can be solved by mechanical applications of the prescribed

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1 See Sec. 13.3.3 below.

2 See also Ex. 1 for Sūtra 16 (III 8) and Ex. 1 for Sūtra 51 (VIII 3) for similar cross-references. Curiously enough, these references are all made in terms of leaf-numbers, which would probably become useless when the work is copied again.

rules, but, as has been alluded to above (Sec. 6.6), the examples of the BM have been given according to rather a loose plan. Thus, the verbal expression of Sūtra 53 had to be modified when it was applied to its second example (VIII 5); and, in order to solve the only extant example for Sūtra 58 (VIII 10), we have to rewrite the formula given in that *sūtra*. I may add that there is not the slightest indication that the Bakhshālī work was modeled on a book of *pāṭī* which divides its subjects into *parikarmāṇi* (fundamental operations) and *vyavahārāḥ* (practical problmes), although it has many problems and rules in common with works of *pāṭī*.

It seems that the BM is, just like the Patan Manuscript,[3] a loose compilation of rules and examples collected from different works. The repetitions disclosed by the above mentioned cross-references also point to the same conclusion. Note also that three different systems of money measures occur in our text.[4]

We, therefore, apparently owe the BM to four types of persons:

1. The authors of the original *sūtras* and *udāharaṇas*.
2. The compiler.
3. The commentator.
4. The scribe.

It is possible that the commentator was the compiler himself; the continuity between the verbal statement of Ex. 42, which is actually a quotation from the *Mahābhārata*, for Sūtra C10 and its solution seems to suggest it.[5] It is also probable that the 'son of Chajaka,' by whom the BM, or at least part of it, was 'written' (*likhita*), was the commentator, or one of the commentators. The colophon to Section X of the text reads thus:

> *idaṃ vasiṣṭhaputrahasikasyārthe putrapautra upayogyaṃ bhavatuḥ likhitaṃ cchajakaputragaṇakarāje brāhmaṇena.* (X 27)
>
> This ⟨book⟩ has been written by the son of Chajaka, a *brāhmaṇa* and king of mathematicians, for the sake of Hasika, son of Vasiṣṭha, in order that it may be used ⟨also⟩ by his descendants.

B. Datta seems to have regarded 'the son of Chajaka' as one of the scribes. He says: 'In any case, it will follow that the present manuscript is a copy. ... Had (the son of) Chajaka been the author of the work, the more appropriate and usual word for this colophon to begin with would have been *kṛtaṁ* or *viracitaṁ* ("composed").'[6] This is correct in so far as ordinary Sanskrit manuscripts are concerned. But a number of irregularities found in the language of the BM make me doubt Datta's assumption that the verb *likh* in the BM, as in other manuscripts, means to write down with writing materials.

In fact, we see the commentator use *likhiṣyāmi* ('I will write') in one passage (X 25), and *vakṣyāmi* ('I will tell') in another parallel passage that occurs on the same page (X 25). This indicates that, for the commentator, the two verbs, *likh* and *vac*, were interchangeable.[7] We should also remember that the words, *likhita* and *abhilikhita*, as well as *vivardhita*, are used in the above mentioned

3 See Appendix G.
4 See Sec. 12.5 below.
5 See Sec. 13.2.1 below.
6 Datta 1929a, 7. He assumes, instead of the four types, 'three types of scholars: (1) the writer of an original treatise, (2) the commentator, and (3) the scribe.' op. cit., p. 8.
7 The two verbs are used interchangeably also in the *Lokaprakāśa* ascribed to Kṣemendra. Its second chapter begins: *idānīṃ lokalekhaśikṣācaritaṃ likhyate* ('Now, the practice of writing skill in worldly affairs is written'); and the third: *athātaḥ saṃpravakṣyāmi tṛtīyaṃ* ... ('From now on, I will explain the third ⟨chapter⟩. ... ')

cross-references. If Datta's assumption about the meaning of the verb *likh* be right, we would have to regard those references as having been made by the scribe(s). Moreover, it would be unusual if the *brāhmaṇa*, who calls himself 'king of mathematicians,' was merely one of the copiests. We, therefore, cannot agree to Datta's opinion that the son of Chajaka was a copiest.

That the present manuscript of the Bakhshālī work was written down, not by the compiler himself, but by a later person (or persons), is inferred from the statement: '*sūtre bhrāntim asti*' ('There is a corruption in the ⟨numbering of this⟩ *sūtra*,' III 8). This brief remark, which is written by the same hand as the other part of the same page, cannot have been made by the compiler himself, who would have corrected the corruption instead of simply remarking it, if he had ever noticed it.

CHAPTER 8

Abbreviations and Symbols

A number of abbreviations occur in the BM (see Index). Indeed, any word may be abbreviated in our text, when it is used in a tabular presentation of numerical data (*nyāsa* or *sthāpana*) and in the result (*phala*) of computation. Usually, the first syllable (*akṣara*) represents the word; for example, the '*a*' can stand for *akṣauhiṇī* (X 9), or *aṅgula* (X 10), or *aṇḍikā* (X 5), or *aśva* (III 5). The ambiguity which one would naturally expect rarely occurs, as the original words are usually found in the vicinity of the abbreviations.

Sometimes the first two syllables are used. Thus we find *parā* for *parāvarta* (X 9), *mahi* for *mahiṣī* (II 6), and *yoja* (besides *yo*) for *yojana* (X 9 and 14). The word *udāharaṇa* (example) is almost always abbreviated *udā*, while the word *sūtra* (versified rule) is never contracted.

More important for the history of mathematics are abbreviations of the terms for mathematical operations. We find in the BM *yu* for *yuta* (increased), *gu* for *guṇa* or *guṇita* (multiplied), *bhā* for *bhājita* (divided) or *bhāgahāra* (divisor or division), *che* for *cheda* (divisor), and *mū* for *mūla* (square root). For subtraction, our text uses the symbol, +, whose form very much resembles that of the modern symbol for addition. Usage of these symbols may be summarized as follows (A, B, and C indicate numerical figures).

1. Addition, $A + B$:
   - AB *yu* (VIII 2)
   - A *yu* B (VIII 2)
2. Subtraction
   (a) $A - B$:
   - $AB+$ (I 8, II, 6, VII 3, 9, VIII 2, X 1, 6, 9, 12, 20)
   - $\begin{array}{|c|} A \\ B+ \end{array}$ (IX 3, where B is a fraction)

   (b) $A(1 - B)$, where B is a fraction:
   - $\begin{array}{|c|} A \\ B+ \end{array}$ (II 10, III 19, 20, 21, 22, 24, 25, 26, 27, 30)

   (c) $Ax - B$, where x is an unknown number:
   - $\begin{array}{|c|} B+ \\ A \end{array}$ (II 1, 6)
   - $\begin{array}{|ccc|} A & B & + \\ \hline \end{array}$ (IV 10, 11)

3. Multiplication

   (a) $A \times B$

   ∘ A B *gu* (IV 9, X 12)

   (b) $A \times B \times \cdots \times C$:

   ∘ $AB \cdots C$ *gu* (X 23)

4. Division, A/B:

   ∘ AB *bhā* (VII 3, IX 1, 3, X 1, 2, 3, 12, 13, 21)

   ∘ B *bhā* A (I 7, III 19, 22, 25, 26, 30, X 12)

   ∘ *bhā* BA (I 9)

   ∘ | A / B *bhā* | (III 21)

   ∘ | A / B *che* | (X 21)

5. Square root, $\sqrt{A}$:

   ∘ A *mū* (VIII 2)

The negative sign, +, is almost regularly attached to subtractive/negative numbers, and its place is, in the BM, fixed at the right of the affected number. On the other hand, the abbreviations, *yu*, etc., are employed sporadically; usually in the BM, as in other mathematical texts, addition and multiplication are indicated by juxtaposition of the numbers, and division by putting the divisor below the dividend. Thus, the abbreviations are used only supplementarily, and are not completely free of Sanskrit syntax; for example, the division of 2 by 3, which may be expressed verbally as *dvayaṃ tribhājitaṃ* (or *trayena bhājitaṃ*), would naturally be noted as '2 3 *bhā*.'

The origin of the negative sign, +, has been variously conjectured. Thibaut is said to have pointed out the apparent resemblance between this and the Diophantine sign (⋔) for subtraction,[1] but we have no reason to believe in their historical relationship. The above mentioned usage of the abbreviations seems to indicate a similar origin of the negative sign. Hoernle tried, with hesitation, to relate the symbol to the Aśokan Brāhmī letter *ka* (+) for *kanita* (diminished), but the word *kanita* has not so far been found used in mathematical contexts.[2]

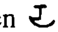
Datta conjectured that it might have been an abbreviated form of the Brāhmī letter *kṣa* for *kṣaya* (decrease). This appears to be plausible to some extent, since the letter *kṣa* used in Brāhmī inscriptions of the early centuries of the Christian era exhibits the form 𑀓𑁆𑀱, the bottom flourish of which might, as Datta conjectured, have been dropped for convenience, and the word *kṣaya* for the negative quantity is as common as *ṛṇa* (debt) in our text (see Index) as well as in other mathematical works.[3]

K.S. Shukla, however, has correctly pointed out the possibility that the symbol may have originated from a Brāhmī letter *ṛ* for *ṛṇa*, the most common word for the negative quantity,[4] but the

1 Hoernle 1888, 34.
2 Hoernle, *loc.cit.*
3 Datta 1929a, 18. For the letter, see Dani 1963, Plates VIb, VIIIb, etc.
4 Shukla 1976, lxxii, fn.1.

letter form, , assigned by him actually has the sound value '*ri*' in the Brāhmī script.[5] I would rather point to the letter '×' for the initial '*ṛ*' used in some of the inscriptions of the later Western Kṣatrapa rulers (late second and third centuries).[6] Compare also the following letter forms of the initial *ṛ* that are used in the manuscripts discovered at Turfan:[7]

 in the Kuṣāṇa script (ca. 2nd and 3rd centuries)
 in the Gupta script (4th and 5th centuries)
 in the later Gupta script (ca. 6th century).

It is remarkable that both forms, + and ×, of the negative sign occur in the Kashmir manuscript (written in the later type of the Śāradā script) of the anonymous commentary on the *Pāṭīgaṇita*.[8] In Śāradā, the initial *ṛ* is written . It is, therefore, most probable that originally in a certain type (or types) of the Kuṣāṇa or Gupta script (ca. second to sixth centuries) the word *ṛṇa* indicating the negative number was abbreviated *ṛ* (× or +) just as in the case of the other mathematical operations, and that the letter survived as a pure symbol even after the script had been changed.

Another important abbreviation used in the BM is *yā* for *yāvattāvat*, the most popular symbol for the unknown quantity in *bījagaṇita*.[9]

A dot (·) is used for denoting a vacant place both in the decimal notation and in the 'statement' or the tabular presentation of numerical data in the BM: in the former case it stands for a cipher, and in the latter for an unknwon number. A dot for the unknown is commonly used in later commentaries also. We have too few materials to confirm the conjecture that a dot for zero is older than a circle used for the same purpose, although it is likely.[10]

The history of abbreviations in general in India is not known very well, but they seem to have been popular from early times. According to D.C. Sircar, it is from about the early centuries of the Christian era that abbreviations began to appear in the date portion of inscriptions: e.g., *di* for *divasa* (day), *pa* for *pakṣa* (fortnight), *va* for *varṣa* (year), etc.[11] 'From about the 6th century,' says Sircar, 'abbreviations like *dū* for *dūtaka*, *rū* for *rūpaka*, *dvi* for *dvitīya*, etc. occur in West-Indian inscriptions, while in later records contractions of titles, technical terms, etc. appear very often.'[12] Interestingly, the abbreviations, *di, va*, and *dvi* occur in our text also (see Index).

It is well known that Pāṇini's *Aṣṭādhyāyī* (ca. 4th century B.C.) systematically employs symbols for grammatical elements ('*ac*' for all vowels, '*hal*' for all consonants, etc.) in analyzing and describing Sanskrit grammar.[13] In Lagadha's *Jyotiṣavedāṅga* (ca. 400 B.C.), the *nakṣatras* (lunar mansions) are designated by the first (exceptionally the second) or the last syllables of their names.[14]

The younger Bhāskara (A.D. 1150) stipulates the use of initial letters as well as of a dot in mathematics thus:

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5 Dani, op.cit., Plates VIb, VIIb, etc. Shukla's mistake has been corrected by Bag 1979, 85.
6 Dani, op.cit., Plate IXa.
7 Sander 1968, Tables 5, 15, and 23.
8 Shukla 1976, lxxii, fns. 1 and 2, who also mentions the same symbol used in the commentary *Dhavalā* on the *Ṣaṭkhaṇḍāgama*, a Jaina canonical work. According to Prof. Pingree (personal communication), the same symbol (+) frequently occurs in astronomical tables.
9 See Sec. 6.6 above.
10 Datta and Singh 1935/38, Part 1, 81–82.
11 Sircar 1965, 220 and 327.
12 Sircar, op.cit., 328. Cf. also Sircar 1974, 123–130.
13 See, for example, Cardona 1968 and 1988.
14 Lagadha, *Jyotiṣavedāṅga*, stanza 14 of the Ṛc recension and stanza 18 of the Yajus recension (see p.56 of Sarma's edition).

> *atra rūpāṇām avyaktānāṃ cādyākṣarāṇy upalakṣaṇārthaṃ lekhyāni. tathā yāny ūnagatāni tāny ūrdhvabindūni ca.*[15]
>
> Here (in mathematics), the initial letters of ⟨the names of⟩ known and unknown quantities should be written down as their signs. Likewise, those ⟨numbers⟩ which are negative have a dot over them.

Although Bhāskara does not mention 'signs' for operations other than subtraction, the initial letters of their names are naturally supposed to have been used when many operations were involved in one problem, as in examples for the rule of inversion (cf. Sūtra C1 of the BM). For example, Mahīdhara (A.D. 1585/1599), in his comment on *Līlāvatī* 50 (an example for the rule of inversion), uses *yu* for *yuta*, *kṣe* for *kṣepa* (additive), *ṛ* for *ṛṇa*, *gu* for *guṇa*, *bhā* for *bhāgahāra*, *hā* for *hāra* (divisor), *va* for *varga* (square), and *mū* for *mūla*. Also, the elder Bhāskara (A.D. 629), in his commentary on *Āryabhaṭīya* 2.28 (rule of inversion), employs the abbreviations: *kṣe*, *ū* for *ūna* (negative), *gu*, and *hā*.

15 Bhāskara, *Bījagaṇita* 5.

CHAPTER 9

Numerical Expressions

9.1 Bhūtasaṃkhyā

The only *bhūtasaṃkhyās* found in the extant BM, besides the trivial cases *śūnya* (= 0) and *rūpa* (= 1), are *bhūta* (= 5) and *rasa* (= 6). They occur in the passages:

bhūtaṃ paṃcaguṇaṃ sa⟨ṃvatsarāṇāṃ⟩ (X 1)

Five times five (i.e., 25) years.

dvitīyaṃ paṃcadivase rasam ārjayate (VIII 4)

The second ⟨man⟩ earns six ⟨units⟩ every five days.

Preference of the ordinary numerals to the *bhūtasaṃkhyās* is noticed also in Śrīdhara's *Triśatikā* and *Pāṭīgaṇita*.[1]

9.2 Numerals

In the verses of the BM, as in those of other mathematical works, integers are sometimes expressed according to the principle of multiplication so that the expressions meet metrical requirements. Thus,

paṃca triguṇitā (X 11) = $3\times5 = 15$;
saptate dviguṇāyāś (III 20) = $70\times2 = 140$;
divardhaṃ śataṃ (II 10) = $1.5\times100 = 150$; and
catuvargaṃ (VIII 9) = $4^2 = 16$.

'N plus $\frac{1}{2}$' is expressed often by adding the word *sārdha* immediately before or after the word denoting N, but sometimes according to the principle of division: $N + \frac{1}{2} = \frac{2N+1}{2}$. Examples of the latter case are:

paṃcārdha (IV 9, X 16) = $\frac{5}{2}$;
saptārdha (IV 9) = $\frac{7}{2}$; and
navārdha (IV 9) = $\frac{9}{2}$.

The expression, *ardha* + ordinal of $(N + 1)$, which is commonly used to denote $(N + \frac{1}{2})$ in Sanskrit literature, never occurs in our text, although this cannot be regarded as being peculiar to the BM, since the expression is rare in other mathematical works also.

1 See Sec. 13.3.4 below.

9.3 Expressions of Computations

The expressions of computations that occur in the 'computation' (*karaṇa*) of the BM are summarized below.[2]

We have to keep it in our mind that no equations occur in the BM, although equations having two sides were knwon in the time of Brahmagupta (A.D. 628).[3] Apparently, some of the expressions listed below have come very near the modern algebraic equations, but they are actually mere tabular presentations of the numerical data, and are not equations to be the objects of operations. Expression 6–j, for example, which occurs in the text as:

0	5 *yu*	*mū* 0	*sā* 0	7+	*mū* 0
1	1	1	1	1	1

faithfully follows the verbal expression of the problem:

> *ko rāśi paṃcayutā mūladaḥ sā rāśis saptahīnaḥ (+),*
> *mūlada ko so rāśir iti praṣṭaḥ.*
>
> What number, when increased by five, has a square root? The same number, when decreased by seven, has a square root. What is that number? This has been questioned.

The answer to this problem is obtained not by means of the transformation of the equations, but according to the algorithm prescribed in Sūtra 50.

1. Addition

   (a) $A + B = C$:

   - $A\ \ B$ *yutaṃ* C (III 27)
     - The word *yutaṃ* may be replaced by *tadyuti* (III 35), *jātā* (I 8), *evaṃ* (III 20), and the like.
   - A *yutaṃ* B *jātaṃ* C (I 8)
   - $A\ \ B\ \ C$ (I 9)

   (b) $A + B + \cdots + C = D$:

   - $A\ \ B \cdots C$ *evaṃ* D (IV 4, 5, 6, V 4)
     - The word *evaṃ* may be replaced by *eṣāṃ yutaṃ* (II 7), *ekattraṃ* (II 7), *ekattre* (I 4), *ekāṃ* (V 1(?)), *yoga* (II 8), *prakṣiptaṃ* (IV 5), and the like.
   - $\begin{array}{|c|} A \\ B \\ \vdots \\ C \end{array}$ *evaṃ* D (III 3)

   (c) $A + \frac{B}{C}$:

   - $\begin{array}{|c|} A \\ B \\ C \end{array}$ (I 9, etc.)

---

2 For the abbreviations of the terms for operations, see Chapter 8 above. The unknown number expressed by 0 in 6–e to 6–j is actually denoted by a dot (·) in the manuscript.

3 Brahmagupta, *Brāhmasphuṭasiddhānta* 18.43.

(d) $A(1+B)$, where B is a fraction:

- $\left|\begin{matrix}A\\B\end{matrix}\right|$ (X 14, etc.)

2. Subtraction

(a) $A-B=C$:

- A $B+$ *śeṣaṃ* C (VII 3, 7)
- B A *viśeṣaṃ* C (I 17, III 7)
  - The word *viśeṣaṃ* may be replaced by *pātya śeṣaṃ* (I 9).

(b) $A-\frac{B}{C}$:

- $\left|\begin{matrix}A\\B+\\C\end{matrix}\right|$ (I 9, etc.)

(c) $A(1-B)$, where B is a fraction:

- $\left|\begin{matrix}A\\B+\end{matrix}\right|$ (III 19, etc.)

3. Multiplication

(a) $A\times B=C$:

- A B *guṇitaṃ jātaṃ* C (III 21, 27, VII 2)
  - The words *guṇitaṃ jātaṃ* may be replaced by *abhyāsaṃ* (VI 4), *phalaṃ* (III 29), *jātā* (IV 6), and the like.

(b) $A\times B\times\cdots\times C=D$:

- A $B\cdots C$ *guṇitaṃ (jātaṃ)* D (III 23, 28, 30)

4. Division, $A/B=C$:

- ... *anenātra bhāga* $\left|\begin{matrix}A\\B\end{matrix}\right|$ *labdhaṃ* C (V $1(^{d})$)
- $\left|\begin{matrix}A\\B\end{matrix}\right|$ *vartyaṃ (jātaṃ)* C (IV 4, V 2, VII 2)
- $\left|\begin{matrix}A\\B\end{matrix}\right|$ *vartitaṃ jātā phalaṃ* C (IV 3)
- B *vibhaktaṃ* $\left|\begin{matrix}1\\B\end{matrix}\right|$ A *(guṇita) jātā* C (III 8)
  - In this case, the divisor is converted into its reciprocal, and the latter is multiplied by the dividend. The word *vibhaktaṃ* may be replaced by *bhaktaṃ* (II 10, IV 1), *bhakte* (III 30), and *bhaktvā* (II 9).

5. Combined operations

   (a) $(A - B)C - D$:

   ∘ $\underline{\left| \; A \quad B+ \quad C \quad D+ \; \right|}$ (I 8)

   (b) $(A + B)/C + D$:

   ∘ $\underline{\left| \; D \quad C \quad bh\bar{a} \quad B \quad A \; \right|}$ (I 7)

   - The order of the numerical figures in this expression is unusual, because it occurs in an example for the rule of inversion.

   (c) $A - (B/2)/D$:

   ∘ $\left| \begin{array}{ccccc} A & B & 1 & D & bh\bar{a} \\ & & 2 & & + \end{array} \right|$ (VII 3, 6)

   (d) $\frac{C(1+D)E(1-F)}{A(1+B)} - \frac{GH}{J} - \frac{I}{J}$:

   ∘ $\left| \begin{array}{cccccccccc} A & bh\bar{a} & C & E & gu & G & H+ & I+ & J & bh\bar{a} \\ B & & D & F+ & & & & & & \end{array} \right|$ (X 12)

6. Expressions involving unknowns

   (a) $Ax + B$:

   ∘ $\frac{B}{A}$ (II 1)

   (b) $Ax - B$:

   ∘ $\frac{B+}{A}$ (II 1, 6)

   ∘ $\underline{\left| \; A \quad B+ \; \right|}$ (IV 10, 11)

   (c) $\{A + B(1 - C) + D(1 - E)(1 - F)\}x = G$:

   ∘ $\left| \begin{array}{c|c|c|} A & B & D \\ & C+ & E+ \\ & & F+ \end{array} \right.$ *pha* G (II 10)

   (d) $Ax + Bx + Cx + Dx = E$:

   ∘ $\underline{\left| \; A \mid B \mid C \mid D \mid dr\acute{s}ya \; E \; \right|}$ (IV 8, 9, 10, 11)

   - The word *dṛśya* means 'visible.'

   (e) $x + Ax + Bx + Cx = D$:

   ∘ $\left| \begin{array}{c|c|c|c|c} 0 & A & B & C & dr\acute{s}ya \; D \\ 1 & & & & \end{array} \right|$ (IV 4)

   (f) $x + Ax + BAx + CBAx = D$:

   ∘ $\left| \begin{array}{c|c|c|c|c} 0 & tad\bar{a} \; A & tad\bar{a} \; B & tad\bar{a} \; C & dr \; D \\ 1 & & & & \end{array} \right|$ (IV 5)

   - The word *tadā* means 'then,' and *dṛ* is an abbreviation of *dṛśya* ('visible').

   (g) $x + Ax + PBx + QCx = D$, where $P = 1 + A$, and $Q = 1 + A + (1 + A)B$:

   ∘ $\left| \begin{array}{c|c|c|c|c} 0 & A & P \; B & Q \; C & dr\acute{s}ya \; D \\ 1 & & & & \end{array} \right|$ (IV 6)

(h) Three types of equations treated in Sūtra N11 and N12 are all expressed as:

∘	0 *A* 1	*P B*	*Q C*	*R D*	*dṛśya E*

(IV 7, 8, 9, 10, 11)

(i) $x(1-A)(1-B)(1-C) = D$, hence $x = \frac{D}{(1-A)(1-B)(1-C)} = E$:

∘	0	1	1	1	*bhā D*	*phalaṃ E*
	1	*A*+	*B*+	*C*+		

(III 19)

(j) $\sqrt{x+A} = u$, and $\sqrt{x-B} = v$:

∘	0	*A yu*	*mū* 0	*sā* 0	*B*+	*mū* 0
	1		1	1		1

(VIII 2)

CHAPTER 10

Classifications of the Rules

10.1 Topics

Apart from the cited rules (designated by Sūtra Q-), most of which are concerned with fundamental operations, many rules of the BM could belong to the *miśrakavyavahāra* (practical problems on mixture) and the *śreḍhīvyavahāra* (practical problems on series) in a book of *pāṭī* such as Śrīdhara's *Pāṭīgaṇita*, etc. There is, however, not the slightest indication that the rules of the BM have been arranged according to the ordinary categories of *vyavahārāḥ* (practical problems); in fact, we can hardly find any principle in the arrangement of the rules (*sūtrāṇi*) of the BM.

The following is a loose classification of the rules that occur in the extant portion of the BM; some of them are classified under more than one category for the sake of convenience.

	Sūtras
1. Fundamental operations	
(a) Addition and subtraction of negative quantities	Q10
(b) Reduction (addition) of fractions	Q1
(c) Multiplication of fractions	Q3, Q7
(d) Division of fractions	Q4
(e) Reduction of measures (*vallīsavarṇa*)	Q6
(f) Root-approximation formula	Q2
2. General rules applicable to different kinds of problems	
(a) Regula falsi (*iṣṭakarman*)	N8, N9, N10, N11, N12
◦ Each of these *sūtras* is prescribed for a particular type of problems.	
(b) Rule of inversion (*viparītakarman/vyastavidhi*)	C1
(c) Rule of three (*trairāśika*)	C10, N19, Q11
(d) Proportional distribution (*prakṣepaka*)	N1, N13, C6
(e) Partial addition and subtraction (*caturthajāti* and *pañcamajāti*)	25, 26, C4

3. Rules for purely numerical problems (including almost purely numerical problems of properties).
   (a) Simple equations with one unknown 51
   (b) Systems of linear equations with more than one unknown 10, N6, N8, N9, N10, N11, N12, N15
   (c) Indeterminate equations .... 50, N16, N17(?)
   (d) Period of an arithmetical progression N18
4. Rules for problems of money
   (a) Equations of properties, wages, earnings, donations, etc. (*samadhanatā*) 18, 20, 21, 23, 53, C2
   (b) Consumption of income and savings 52, C9
   (c) Buying and selling (*krayavikraya*) 54, 55, 56, 57
   (d) Purchase in proportion N3
   (e) Purchase of the same number of articles N4
   (f) Price of a jewel 11
   (g) Prices of living creatures C7
   (h) Mutual exchange of commodities 13
   (i) Installments N7
   (j) A sales tax paid both in cash and in kind 58
   (k) A bill of exchange (*huṇḍikā*) N2
5. Rules for problems of travelers
   (a) Equations of journeys (*samagati*) 15, 16, 17, 19, N5
   (b) Meeting of two travelers 24, C3
   (c) A chariot and horses 22
6. Rules for problems of impurities of gold (*suvarṇakṣaya*) 27, 28, 29
7. Rules for geometrical problems
   (a) Volume of an irregular solid (*vāhakāṇḍa*) N14
   (b) Proportion in geometry(?) C5

10.2 Equations

The problems that are treated in the extant portion of the BM can be divided into the following five categories according to the equations involved. In the equations given below, the letters, x, y, u, and v, with or without subscripts, stand for unknown quantities unless otherwise indicated.

Sūtras

1. Simple equations with one unknown

   (a) $a : b = c : x$ (*trairāśika*) C10, N19, Q11
   (b) $\frac{d}{n} = \frac{D}{N}$ (d unknown) 22
   (c) $p(1 + a_1)(1 + a_2) \cdots (1 + a_n) = q$ (p unknown) 26
   (d) $x(1 + a_1)(1 + a_2) \cdots (1 + a_n) + b = x$ .... Ex. 1 for C4
   (e) $KW = k_1 w_1 + k_2 w_2 + \cdots + k_n w_n$ 27, 28
      - K unknown in 27 and k_i unknown in 28.
   (f) $ax + b = cx + d$ 51
   (g) $\frac{na}{p} = ma + b$ 58
      - b is unknown in the rule of 58, but a is unknown in Ex. 1 for 58.
   (h) $v_1 t - D = D - v_2 t$ (t unknown) 24
   (i) $v_1 t + v_2 t = D$ (t unknown) C3
   (j) $v_1 t_1 + v_1 t_2 = v_2 t_2$ (t_2 unknown) 15, N5
   (k) $at + c = bt$ (t unknown) 52, C9
   (l) $\frac{a_1}{t_1} t - c = \frac{a_2}{t_2} t + c$ (t unknown) 53, C2
   (m) $\frac{a_1}{t_1} t + \frac{a_2}{t_2} t + \cdots + \frac{a_n}{t_n} t = p$ (t unknown) N7
   (n) $\left\{a + \frac{(n-1)d}{2}\right\} n = cn$ (n unknown) 20, 21, 23
   (o) $\left\{a_1 + \frac{(n-1)d_1}{2}\right\} n = \left\{a_2 + \frac{(n-1)d_2}{2}\right\} n$ (n unknown) 16, 17, 18

2. Systems of linear equations with more than one unknown

   (a) $\begin{cases} x + p = a(y - p) \\ y + q = b(x - q) \end{cases}$ 10
   (b) $\begin{cases} aN = bM \\ M = N + L \end{cases}$ 54, 55, 56, 57
      - M and N unknown in 54, 57; L and M unknown in 55; and L and N unknown in 56.
   (c) $\begin{cases} V + K = v_i + k_i = 16 \\ VW = v_1 w_1 + v_2 w_2 + \cdots + v_n w_n \end{cases}$ (W, V, v_i unknown) 29
   (d) $\begin{cases} x_1 : x_2 : \cdots : x_n = m_1 : m_2 : \cdots : m_n \\ x_1 + x_2 + \cdots + x_n = p \end{cases}$ N1, N13
   (e) $\begin{cases} a_1 : a_2 : \cdots : a_n = A_1 : A_2 : \cdots : A_n \\ A_1 + A_2 + \cdots + A_n = p \end{cases}$ C6
      - $A_1, \cdots, A_j$, and $a_{j+1}, \cdots, a_n$ unknown.
   (f) $\begin{cases} x_1 : x_2 : \cdots : x_n = m_1 : m_2 : \cdots : m_n \\ \frac{y_i}{x_i} = \frac{b_i}{a_i} \\ y_1 + y_2 + \cdots + y_n = p \end{cases}$ N3

(g) $\begin{cases} p(x_i - a_i) - b_i = x_{i+1} \ (i = 1, 2, \cdots, n-1) \\ x_n = 0 \end{cases}$ .... Ex. 1 for C1

(h) $\begin{cases} x_i = a_i x_0 + b_i \ (i = 1, 2, \cdots, n) \\ x_1 + x_2 + \cdots + x_n = p \end{cases}$ N6

(i) $\begin{cases} x_1 = a_1 x_0 \\ x_i = a_i x_1 \ (i = 2, 3, \cdots, n) \\ x_1 + x_2 + \cdots + x_n = p \end{cases}$ N8

(j) $\begin{cases} x_1 = a_1 x_0 \\ x_i = a_i x_{i-1} \ (i = 2, 3, \cdots, n) \\ x_1 + x_2 + \cdots + x_n = p \end{cases}$ N9

(k) $\begin{cases} x_1 = a_1 x_0 \\ x_i = a_i(x_1 + x_2 + \cdots + x_{i-1}) \ (i = 2, 3, \cdots, n) \\ x_1 + x_2 + \cdots + x_n = p \end{cases}$ N10

(l) $\begin{cases} x_1 = a_1 x_0 + b_1 x_0 \\ x_i = a_i x_1 \pm b_i x_0 \ (i = 2, 3, \cdots, n) \\ x_1 + x_2 + \cdots + x_n = p \end{cases}$ N12

(m) $\begin{cases} x_1 = a_1 x_0 + b_1 x_0 \\ x_i = a_i x_{i-1} \pm b_i x_0 \ (i = 2, 3, \cdots, n) \\ x_1 + x_2 + \cdots + x_n = p \end{cases}$ N11, N12

(n) $\begin{cases} x_1 = a_1 x_0 + b_1 x_0 \\ x_i = a_i(x_1 + x_2 + \cdots + x_{i-1}) \pm b_i x_0 \ (i = 2, 3, \cdots, n) \\ x_1 + x_2 + \cdots + x_n = p \end{cases}$ N12

(o) $\begin{cases} x_1 + x_2 = p_1 \\ x_2 + x_3 = p_2 \\ \cdots \\ x_{2n+1} + x_1 = p_{2n+1} \end{cases}$ N15

3. Quadratic equations

   (a) $vt_1 + vt_2 = \left\{a + \frac{(t_2-1)d}{2}\right\} t_2$ (t_2 unknown) 19

   (b) $S = \left\{a + \frac{(n-1)d}{2}\right\} n$ (n unknown) N18

4. Indeterminate systems of linear equations

   (a) $a_i x_i = y \ (i = 1, 2, \cdots, n)$ N4

   (b) $\begin{cases} \frac{b_1}{a_1} x_1 + \frac{b_2}{a_2} x_2 + \cdots + \frac{b_n}{a_n} x_n = q \\ x_1 + x_2 + \cdots + x_n = p \end{cases}$ C7

   (c) $\begin{cases} \frac{b_i}{a_i} x_i + (x_1 + x_2 + \cdots + x_{i-1} \\ \quad +x_{i+1} + \cdots + x_n) = y \quad (i = 1, 2, \cdots, n) \end{cases}$ 13

5. Indeterminate equations of the second degree

   (a) $\begin{cases} \sqrt{x+a} = u \\ \sqrt{x-b} = v \end{cases}$ (u, v: rational numbers) 50

   (b) $xy = ax + by$ .... N16, N17(?)

CHAPTER 11

Root-Approximation Formulas

The Bakhshālī formula (Sūtra Q2) for extracting the square root of a non-square number K may be expressed in general terms as:

$$p_{i+1} = p_i + \frac{E_i}{2p_i} \quad (i = 1, 2, 3, \cdots), \tag{11.1}$$

where

$$E_i = K - p_i^2$$

and

$$E_{i+1} = -\left(\frac{E_i}{2p_i}\right)^2,$$

of which the first two cases ($i = 1, 2$) are treated in Sūtra Q2. This formula is equivalent to the one taught by Heron (the latter half of the first century A.D.):[1]

$$p_{i+1} = \frac{p_i + \frac{K}{p_i}}{2}. \tag{11.2}$$

It has been suggested that formula (11.2) may have been used for obtaining the two Old Babylonian values of $\sqrt{2}$ expressed in the sexagessimal notation (ca. 1800 to 1600 B.C.):[2]

$$\sqrt{2} \approx 1;25$$

$$\sqrt{2} \approx 1;24,51,10$$

In india, formula (11.2) is given by Jñānarāja (ca. A.D. 1503) in his *Bījādhyāya* ('A Study in Algebra').

āsannamūlena hṛtāt svavargāl labdhena mūlaṃ sahitaṃ dvibhaktam,
bhavet tadāsannapadaṃ tato 'pi muhur muhuḥ syāt sphuṭam mūlam eva.[3]

An approximate square root, increased by the quotient of the division of the proposed (lit. its own) square by that root, and divided by two, will be ⟨another⟩ approximate root of it. From this ⟨value⟩ also, by repeating ⟨the same procedure⟩, a square root of the ⟨desired⟩ exactness will be ⟨obtained⟩.

1 Heath 1921, Vol. 2, 323–326.
2 Neugebauer 1957/69, 35 and 52.
3 Jñānarāja, *Bījādhyāya*, fol. 3b.

Sūryadāsa, son of Jñānarāja, cites the same stanza in his commentary (A.D. 1538) on Bhāskara's *Bījagaṇita*, where the last four syllables are: '*eva mūlam*' instead of '*mūlam eva*.'[4] Also, in his commentary (A.D. 1541) on the *Līlāvatī*, Sūryadāsa cites from his own work, *Gaṇitarahasya*, a stanza that prescribes the same formula in a slightly modified form.

āśritapadakṛtiyuktābhīṣṭakṛtir dviguṇamūlabhaktāptam,
ṣaṣṭighnād avaśeṣāt sāvayavaṃ syān muhur mūlam.[5]

The proposed square is increased by the square of an approximate root, and divided by twice that root. The quotient is accompanied by the fractional portion ⟨that is converted to the sexagesimal notation⟩ by multiplying the remainder ⟨of the division⟩ by sixty. By repeating ⟨the same procedure⟩ there will be a square root ⟨of the desired exactness⟩.

$$p_{i+1} = \frac{p_i^2 + K}{2p_i} \quad (i = 1, 2, 3, \cdots)$$

The latter half of this rule prescribes a method for expressing the remainder of the division sexagesimally. He illustrates the rule by taking $K = 21$: that is, $K = 4^2 + 5$; $p_1 = 4$; and

$$\begin{aligned} p_2 &= \frac{4^2 + 21}{2 \cdot 4} = \frac{37}{8} = 4; 37, 30 \\ p_3 &= \frac{4; 37, 30^2 + 21}{2 \cdot 4; 37, 30} = \frac{42; 23, 26}{9; 15} = 4; 34, 57 \end{aligned}$$

As has been pointed out by Kaye and Datta,[6] the converse of formula (11.1) for $i = 1$ occurs in Brahmagupta's work (A.D. 628) in connection with sexagesimal fractions.

svavikalaṣaṣṭyaṃśaguṇaḥ sakalas triṃśoddhṛto vikalavargaḥ,
prakṣepyaḥ sakalakṛtau ...[7]

The integer, multiplied by the sexagesimal parts of the fraction belonging thereto, and divided by thirty, is the square of the fractional portion, to be added to the square of the whole degree.[8]

That is,

$$\left(a + \frac{b}{60}\right)^2 = a^2 + \frac{ab}{30} + \left(\frac{b}{60}\right)^2 \approx a^2 + \frac{ab}{30}, \qquad (11.3)$$

or, in the sexagesimal notation,

$$(a; b)^2 = a^2; 2\,ab, b^2 \approx a^2; 2\,ab = a^2 + \frac{ab}{30}.$$

Brahmagupta calls this value, $ab/30$, *vikalavarga* or 'the square of the fractional portion.' Substituting E for this value, we can convert the above relation to:

$$\left(a + \frac{E}{2\,a}\right)^2 \approx a^2 + E$$

4 Sūryadāsa, *Sūryaprakāśa*, fol. 22b.
5 Sūryadāsa, *Gaṇitāmṛtakūpikā*, fol. 64a.
6 Kaye 1927/33, 31. Datta 1929a, 49.
7 Brahmagupta, *Brāhmasphuṭasiddhānta* 12.62.
8 Trans. by Colebrooke 1817, 322.

or,

$$\sqrt{a^2+E} \approx a + \frac{E}{2\,a}.$$

It is, therfore, naturally conjectured that formula (11.1) for $i = 1$ was known to Brahmagupta.

This conjecture is strongly supported by the following two stanzas, which have not been appreciated by scholars except by Sengupta, followed by Chakravarti.[9]

> *iṣṭālparāśivargau yuktonāv itaravikalavargābhyām,*
> *dviguṇetararāśibhyāṃ bhaktau tenādhikonābhyām.*
> *sthānāntareṣu labdhaṃ yena samaṃ phalayutonakacchedaḥ,*
> *dalitaḥ kṛtiyogāntarapadam itaro vā phalayutonaḥ.*[10]

> The square of the given least number is increased or decreased by the square of the fractional portion of the other, and divided by twice the other number, and in the second place by the ⟨same divisor⟩ increased or decreased by the ⟨first⟩ quotient that is ⟨taken to be⟩ the same ⟨as the second⟩. The divisor, increased or decreased by the ⟨two equal⟩ quotients, and halved, is the square root of the sum or difference of the squares. Or the other ⟨number⟩, increased or decreased by the quotient, is so.

When the 'least number' c, the 'other number' a, and its fractional portion $b/60$, are given,

$$\sqrt{\left(a+\frac{b}{60}\right)^2 \pm c^2} \approx \sqrt{a^2+\frac{ab}{30} \pm c^2}$$

according to formula (11.3). This may be rewritten:

$$\sqrt{\left(a+\frac{b}{60}\right)^2 \pm c^2} \approx \sqrt{a^2 \pm E},$$

where

$$E = c^2 \pm \frac{ab}{30}.$$

The above two stanzas give the formula,

$$\sqrt{\left(a+\frac{b}{60}\right)^2 \pm c^2} \approx \frac{2\,a \pm 2\,q}{2} = a \pm q, \qquad (11.4)$$

where q is such a number that satisfies the relation,

$$q = \frac{E}{2\,a \pm q}.$$

The number q is, therefore, called 'a quotient' in the stanzas. Theoretically, the resulting value, $a \pm q$, is the exact square root of $(a^2 \pm E)$, and is not its approximation. In fact, by putting

$$\sqrt{a^2 \pm E} = a \pm q,$$

we have

$$a^2 \pm E = a^2 \pm 2\,aq + q^2.$$

9 Sengupta 1927, 14. Chakravarti 1934, 52.

10 Brahmagupta, *Brāhmasphuṭasiddhānta* 12.64–65.

Hence,

$$q = \frac{E}{2\,a \pm q}.$$

In actual cases, however, unless the number, $(a^2 \pm E)$, happens to be a square number, one must content oneself with a 'quotient' that approximately satisfies the above relation; and it may be taken to be $E/2a$ if it is small enough:[11]

$$\sqrt{a^2 \pm E} \approx a \pm \frac{E}{2\,a}.$$

Thus we are probably justified in concluding that the knowledge of formula (11.1) for $i = 1$ existed in India in the time of Brahmagupta.[12]

In the *Tiloyapaṇṇattī* (between the fifth and the ninth centuries A.D.),[13] the diameter of the disk of Jambūdvīpa ('Jambū Island') is stated to be 10^5 *yojanas*,[14] and its circumference 316227 *yojanas*, 3 *krośas*, 128 *daṇḍas*, 1 *vitasti*, 1 *aṅgula*, 5 *yavas*, 1 *yūkā*, 1 *likṣā*, 6 *karmabhūmibālāgras*, 7 *madhyamabhogabhūmibālāgras*, 5 *uttamabhogabhūmibālāgras*, 1 *ratharenu*, 3 *trasareṇus*, 2 *sannāsannas*, and $3\frac{23213}{105409}$ *avasannāsannas*.[15] R. C. Gupta has demonstrated that this circumference is equivalent to

$$316227 + \frac{484471}{632454}\ \textit{yojanas},$$

---

11 It should, however, be noted that the commentator Pṛthūdakasvāmin (A.D. 864), who assumes the two conditions of this rule: $a < \frac{ab}{30}$ and $a < c^2$ (hence $2a < c^2 + \frac{ab}{30}$), apparently expects q to be an integer. He gives two examples. First ex. (for sum): $a = 15, b = 40, c = 14$. Second ex. (for difference): $a = 12, b = 50, c = 10$. In the first example, $a^2 + E$ is a square number. Ms. fols. 97b–99a. Cf. Colebrooke 1817, 323, fn. 7.

12 Sengupta 1927, 14, interprets the two stanzas of Brahmagupta as containing the formula:

$$\sqrt{a^2 \pm E} \approx a \pm \frac{E}{2a \pm \frac{E}{2a}}.$$

This interpretation not only does not agree with Pṛthūdakasvāmin's, but also cannot explain the relative clause, *tena ... yena*, the word *sama*, and the last *pāda*, '*itaro vā phalayutonaḥ*' of the stanzas. In his astronomical work, *Śiṣyadhīvṛddhida* 4.51, Lalla (8th century) teaches a formula for squaring numbers expressed sexagesimally:

$$(a;b)^2 = \left(a + \frac{b}{60}\right)^2 = a^2 + \frac{2ab + \frac{b^2}{60}}{60}.$$

Cf. formula (11.3) above. And in the next stanza (4.52), he prescribes a formula for extracting the square roots:

$$\sqrt{K} = a + \frac{60(r+1) + b}{2a + 2},$$

where

$$K = a^2 + r + \frac{b}{60}.$$

The same formula occurs in a recension of the anonymous work on mathematics, *Pañcaviṃśatikā* (before A.D. 1428). See Hayashi 1991, 434. The formula may be rewritten:

$$\sqrt{K} = a + \frac{E+1}{2(a+1)},$$

where $K = a^2 + E$.

13 Jadivasaha, the author, himself has been assigned to some time between A.D. 473 and 609, but the work is said to contain interpolations as late as the beginning of the ninth century. See *Tiloyapaṇṇattī*, Vol. 2, Introduction, pp. 7 and 20.

14 Jadivasaha, *Tiloyapaṇṇattī* 4.11.

15 Jadivasaha, *Tiloyapaṇṇattī* 4.50–57.

and that this approximation was obtained by using the Jaina formula for the circumference of a circle:

$$c = \sqrt{10\,d^2},$$

and formula (11.1) for $i = 1$.[16] I may further conjecture that the approximation was computed by making use of the popular algorithm for root-extraction taught by Āryabhaṭa (A.D. 499) and others. The algorithm is applied to numbers expressed in the decimal place-value notation.

> *bhāgaṃ hared avargān nityaṃ dviguṇena vargamūlena,*
> *vargād varge śuddhe labdhaṃ sthānāntare mūlam.*[17]
>
> ⟨Having subtracted the greatest possible square from the last square place (i.e., odd place)⟩, one should always divide the non-square ⟨place⟩ by twice the square root. While the square ⟨of the quotient⟩ is subtracted from the square ⟨place⟩, the quotient is ⟨put down⟩ at the next place as ⟨part of⟩ the square root.

Figure 11.1 illustrates the working process when this rule is applied to 10^{11}. Thus the algorithm produces both 316227 (for p_1) and 484471 (for E_1) simultaneously. Hence,

$$p_2 = p_1 + \frac{E_1}{2p_1} = 316227 + \frac{484471}{632454}\ \textit{yojanas}.$$

It is probably this method that Siddhasena, a Jaina commentator of the early eighth century,[18] meant when he stated thus:

> The diameter is one hundred thousand *yojanas*; that multiplied by one hundred thousand *yojanas* become squared; this is again multiplied by 10 and then the square root (of the product) extracted. The root will be the circumference of the circle. Now to find the number of *yojanas* (by extracting the square root) we obtain in succession the figures 3, 1, 6, 2, 2, and 7 of the root, the number appearing below (that is, as the last divisor) is 632454. This being halved becomes the number three hundred thousand sixteen thousand two hundred and twenty-seven. The number in excess as the remainder is this 484471; ...[19]

It is, therefore, not impossible that formula (11.1) for $i = 1$ was known in India in connection with the popular algorithm in the time of Āryabhaṭa (born A.D. 476) or even earlier.

It should also be mentioned that this algorithm, when combined with the equation:[20]

$$\sqrt{K} = \frac{\sqrt{c^2 K}}{c}, \tag{11.5}$$

could afford an approximate root of K exact to any desired order.

---

16 Gupta 1975. Cf. Datta 1929b, 132.

17 *Āryabhaṭīya* 2.4. Cf. *Pāṭīgaṇita* 25–26 = *Triśatikā* 12–13; *Gaṇitasārasaṃgraha*, parikarman 36; *Mahāsiddhānta* 15.6–7; *Siddhāntaśekhara* 13.5 = *Gaṇitatilaka* 23; *Līlāvatī* 22; and *Gaṇitakaumudī* 1.19–20.

18 Sukhlal 1930, Introduction, pp. 59–60.

19 Siddhasena, *vṛtti* on *Tattvārthādhigamasūtra* 3.11, as cited (in translation) by Datta and Singh 1935/38, Part 1, 171–172.

20 Śrīdhara, *Pāṭīgaṇita* 118 = *Triśatikā* 46. He, however, tells us to leave aside the remainder. Cf. the following rules:
Mahāsiddhānta 15.55: $\sqrt{\frac{b}{a}} = \frac{\sqrt{10000ab}}{100a}$
Siddhāntaśekhara 13.36: $\sqrt{\frac{b}{a}} = \frac{\sqrt{10000ab}}{100a}$ or $\frac{\sqrt{abc^2}}{ac}$
Līlāvatī 140: $\sqrt{\frac{b}{a}} = \frac{\sqrt{abc^2}}{ac}$

			3		1		6		2		2		7		
		n	s	n	s	n	s	n	s	n	s	n	s		
		1	0	0	0	0	0	0	0	0	0	0	0		
3^2=			9	(–											
3×2=	6	)	1	0	(	1									
				6											
				4	0										
1^2=					1	(	–								
31×2=	6	2	)	3	9	0	(	6							
				3	7	2									
					1	8	0								
6^2=						3	6	(	–						
316×2=	6	3	2	)	1	4	4	0	(	2					
					1	2	6	4							
						1	7	6	0						
2^2=									4	(	–				
3162×2=	6	3	2	4	)	1	7	5	6	0	(	2			
						1	2	6	4	8					
							4	9	1	2	0				
2^2=											4	(	–		
31622×2=	6	3	2	4	4	)	4	9	1	1	6	0	(	7	
							4	4	2	7	0	8			
								4	8	4	5	2	0		
7^2=												4	9	(	–
316227×2=	6	3	2	4	5	4	)	4	8	4	4	7	1		

s = square place, n = non-square place

Figure 11.1: Extraction of the Square Root of 10^{11}

It is, of course, difficult to connect historically these methods utilizing the scholastic algorithm to the second case of the Bakhshālī formula, i.e., formula (11.1) for $i = 2$. Nor do we have evidence to show that the Bakhshālī formula is historically related to Brahmagupta's two rules mentioned above. But, as there is nothing to indicate direct foreign influence upon the Bakhshālī work, it would be natural to look for its source in India itself. It is interesting that the Bakhshālī formula can be derived from two propositions of the Śulbasūtras (ca. 600 B.C. to A.D. 200 or later), as is demonstrated below.

The extraction of the square root of a number K is equivalent to the squaring of a geometrical figure having area K. The Śulbasūtras prescribe a rule for squaring an oblong thus (see Fig. 11.2).

> *dīrghacaturasraṃ samacaturasraṃ cikīrṣaṃs tiryaṅmānīṃ karaṇīṃ kṛtvā śeṣaṃ dvedhā vibhajya pārśvayor upadadhyāt khaṇḍam. āvāpena tat saṃpūrayet. tasya nirāha uktaḥ.*[21]

21 *Baudhāyanaśulbasūtra* 1.54. Cf. *Āpastambaśulbasūtra* 2.7 and *Kātyāyanaśulbasūtra* 3.2.

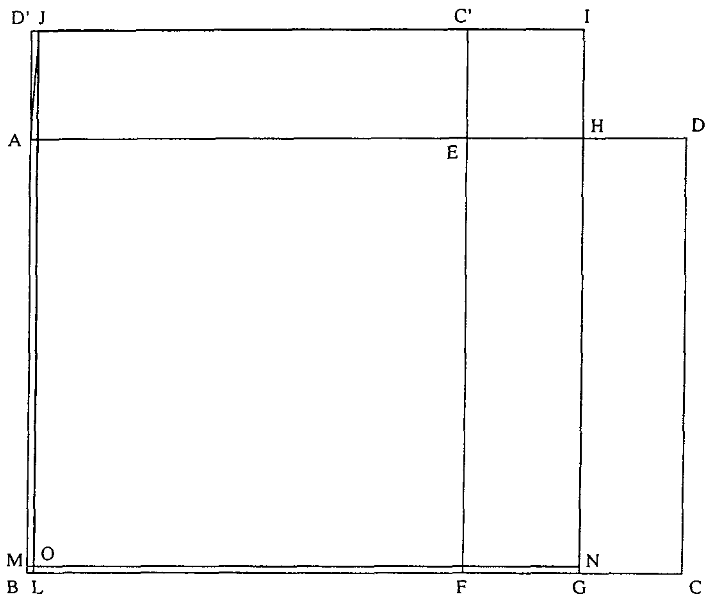


Figure 11.2: Squaring of Oblong ABCD

> One who wishes to transform an oblong (ABCD) into a square should take the shorter side (AB) for the side of a square (ABFE), divide the remainder (CDEF) into two ⟨equal⟩ parts (EFGH and DCGH), and lay the parts on two sides (EF and AE). One should fill that ⟨empty place⟩ (C′EHI) by adding a piece. How to deduct it (the small square added) has been told before.

We may interpret this rule algebraically. Let K be the area of oblong ABCD, p_1 = AB = CD, and p_2 = BG = AH. Then, p_1^2 and p_2^2 can be considered approximations of K, the corresponding errors being E_1 (the area of oblong CDEF) and E_2 (whose absolute value is the area of square C′EHI), that is,

$$K = p_1^2 + E_1 = p_2^2 + E_2,$$

where

$$p_2 = \mathrm{BG} = \mathrm{BF} + \mathrm{FG} = p_1 + \frac{E_1}{2p_1},$$

and

$$E_2 = -\left(\frac{E_1}{2p_1}\right)^2.$$

This is formula (11.1) for $i = 1$. Or, otherwise,

$$p_2 = \mathrm{BG} = \frac{\mathrm{BF} + \mathrm{BC}}{2} = \frac{p_1 + \frac{K}{p_1}}{2}.$$

This is formula (11.2) for $i = 1$.

As a geometrical problem, the squaring is incomplete until the area of the small square added (C′EHI) is removed. The procedure taught by Baudhāyana is thus:

> *caturasrāc caturasraṃ nirjihīrṣan yāvan nirjihīrṣet tasya karaṇyā varṣīyaso vṛdhram ullikhet. vṛdhrasya pārśvamānīm akṣṇayetaratpārśvam upasaṃharet. sā yatra nipatet tad apacchindhyāt. chinnayā nirastam.*[22]
>
> One who wishes to deduct one square (C′EHI) from another square (D′BGI) should cut off a piece (D′AHI) from the larger square with the side (IH) of that square one wishes to deduct. One should draw the longer side (AH) of the cut-off piece (D′AHI) obliquely up to the opposite side ⟨with one end (H) fixed, so that the other end (A) makes an arc (AJ)⟩. One should cut that ⟨side⟩ (D′I) at the point (J) where it (AH) falls. By the ⟨line⟩ (IJ) which has been cut off, ⟨the small square is⟩ deducted ⟨from the larger square⟩.

This procedure geometrically gives the exact side length (IJ) of the square (JONI) that has the required area K:

$$\mathrm{IJ}^2 = \mathrm{HJ}^2 - \mathrm{HI}^2 = \mathrm{D'I}^2 - \mathrm{HI}^2.$$

Now, if one wants to estimate the length IJ numerically, one would naturally proceed thus. The area of the square to be deducted (C′EHI) is equal to that of gnomon D′OG:

$$\left(\frac{E_1}{2p_1}\right)^2 = 2p_2\mathrm{D'J} + E_3,$$

where the absolute value of E_3 is the area of square MBLO. Hence,

$$\mathrm{D'J} = \frac{\left(\frac{E_1}{2p_1}\right)^2}{2p_2} - \frac{E_3}{2p_2} \approx \frac{\left(\frac{E_1}{2p_1}\right)^2}{2p_2},$$

if $E_3/2p_2$ is negligible. Therefore,

$$\mathrm{IJ} = \mathrm{D'I} - \mathrm{D'J} \approx p_2 - \frac{\left(\frac{E_1}{2p_1}\right)^2}{2p_2}.$$

This is the third approximation (p_3) of the Bakhshālī formula. The errors, E_2 and E_3, which are mentioned in the phrase '*kṛtikṣayaḥ*' of Sūtra Q2 according to one of the two interpretations, are here clearly visualized by the square figures, C′EHI and MBLO, respectively.[23]

Virtually the same derivation of the Bakhshālī formula has been suggested by B. Datta, although he does not seem to have recognized the role of the Śulbasūtras' rule for deducting the excessive area.[24] Also, essentially the same method was employed by G. Thibaut in deriving the Śulbasūtras' value of the diagonal (d) of a square:

$$d = a + \frac{a}{3} + \frac{a}{3}\cdot\frac{1}{4} - \frac{a}{3}\cdot\frac{1}{4}\cdot\frac{1}{34}, \tag{11.6}$$

where a is the side-length, although he, probably intentionally, does not explicitly relate the procedure to the existing rules of the Śulbasūtras.[25]

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22 *Baudhāyanaśulbasūtra* 1.51. Cf. *Āpastambaśulbasūtra* 2.5 and *Kātyāyanaśulbasūtra* 3.1.

23 Cf. *Āryabhaṭīya* 2.3: '*vargaḥ samacaturaśraḥ*' ('A square number is ⟨visualized by⟩ a square figure').

24 Datta 1932, 206–208. Cf. Theon's geometric explanation of Ptolemy's method of extracting square roots. Heath 1921, Vol. 1, 60–63.

25 Thibaut 1875, 13–15. Thibaut's conjecture is restated by, among other scholars, Michaels 1978, 143–145, with clear references to the rules of the Śulbasūtras. For different conjectures about the derivation and/or origin (native place) of the Śulbasūtras' value of the diagonal of a square, see Kaye 1919, 329; Chakravarti 1934, 47–48; Neugebauer 1957/69, 35; Gupta 1972; Seidenberg 1978, 327; and Kulkarni 1983, 99–106. Kulkarni conveniently summarizes the opinions of G. Thibaut, C. Müler, B. Datta, A. A. K. Ayyangar, and L. V. Gurjar, and adds his own.

Of course, we cannot prove that the above derivation of the Bakhshālī formula is a historical fact; we can only say that the idea of geometrical derivation of arithmetic or algebraic formulas was known to medieval Indian mathematicians,[26] who were essentially algebraists,[27] and that the geometricians of the Śulbasūtras were not indifferent to arithmetical problems.[28]

26 For example, Śrīdhara (8th century) interprets arithmetical progressions geometrically (*Pāṭīgaṇita* 79–85). Bhāskara (A.D. 1150) geometrically derives his rule for the *bhāvita* type of equations (*Bījagaṇita* 185). Cf. Colebrooke 1817, 271–272.

27 I use this word in its broad sense. Indian mathematicians knew symbols for unknown numbers and skilfully used them in algebraic equations, but, as far as I know, their equations did not contain symbols for known numbers as computational objects. It is, however, to be noted that Gaṇeśa (AD 1545) expressed a *known* number comprising three decimal places as '*yā* 1 *kā* 1 *nī* 1' in order to prove the younger Bhāskara's algorithm for squaring (*Buddhivilāsinī* on *Līlāvatī* 19–20).

28 See Kulkarni 1983, whose main theme is the arithmetical character of the Śulbasūtras.

CHAPTER 12

Weights and Measures

In this chapter the measures and their conversion ratios are, for each category, listed in the Sanskrit alphabetical order in so far as they have been attested in the text of the BM. For each term, at least one reference will be given. I will then summarize those numerical relationships in tabular form, and give remarks when necessary. A pair of angle brackets in the alphabetical lists indicate a restoration.

12.1 Measures of Time

Time units found in the text

2	*ghaṭikās*	=	1	*muhūrta*	X 15
35	*ghaṭikās*	=	1	*dina*[1]	I 18
⟨60	*ghaṭikās*	=	1	*dina*[2]⟩	III 13
60	*ca⟨ṣakas⟩*	=	1	*ghaṭikā*	III 13
30	*dinas*	=	1	*māsa* (month)	X 1, 20
360	*dinas*	=	1	*varṣa* (year)	IX 4, X 8
12	*māsas*	=	1	*varṣa*	X 1, 20
⟨30	*muhūrtas*	=	1	*dina*⟩	X 18
60	*li⟨ptās⟩*	=	1	*ca⟨ṣaka⟩*	III 13
60	*vi⟨liptās⟩*	=	1	1 *li⟨ptā⟩*	III 13

Remark 1

35 *ghaṭikās* = 1 *dina*. This unusual conversion ratio, which is used for 'a day' for travelers, no doubt signifies the time of daylight. Let Cos ω be the earth sine (*kṣitijyā*) of the day on which they are supposed to travel, δ the sun's declination, and ϕ the latitude of the locality. Then we have:

$$35 : 25 = 180 - \omega : \omega$$

or

$$\omega = 75 \text{ degrees},$$

1 *dina* here means 'period of daylight'. See Remark 1 below.

2 A nychthemeron.

Table 12.1: Measures of Time in the *Bakhshālī Manuscript*

	viliptā	*liptā*	*caṣa-*	*ghaṭi-*	*muhū-*	*dina*	*māsa*	*varṣa*
viliptā	1							
liptā	60	1						
caṣaka	60^2	60	1					
ghaṭikā	60^3	60^2	60	1				
muhūrta	$2 \cdot 60^3$	$2 \cdot 60^2$	$2 \cdot 60$	2	1			
dina	60^4	60^3	60^2	60	30	1		
māsa						30	1	
varṣa						360	12	1

and

$$\tan\,\phi = \frac{\cos\,\omega}{\sin\,\delta} = \frac{\cos\,75}{\sin\,\delta}\quad (0 < \delta \leq 23;27).$$

Thus, $\tan\,\phi$, as a function of δ, has the smallest value when δ is the greatest, and so does ϕ itself. Taking δ = 23;27 degrees, we have:

$$\phi = \arctan\left(\frac{\cos\,75}{\sin\,23;27}\right) = 33.039\ldots \approx 33;02 \text{ degrees.}$$

This shows that the latitude of the intended locality is not less than 33 degrees. Compare this with the following latitudes:

Mardan (near Bakhshālī)	34;10 N
Srinagar (Skt. Śrīnagara)	34;06
Peshawar (Skt. Puruṣapura)	34;02
Taxila (Skt. Takṣaśilā)	33;40

Remark 2

Caṣaka. This unit of time occurs only once in the BM (III 13) in its abbreviated form, *ca*, which troubled Kaye and Datta.[3] The identification, *ca* = *caṣaka*, was made for the first time by Prof. David Pingree, to whom I owe the information that the time-unit *caṣaka* is cited by al-Bīrūnī from a certain unidentified work of Bhaṭṭotpala (A.D. 966/969), the Kashmirian. According to 'the tradition of Utpala' as observed by al-Bīrūnī,[4]

$$\frac{1}{60}\ \textit{ghaṭī} = 1\ \textit{caṣaka} \text{ or } \textit{kalā} \text{ or } \textit{vighaṭikā} \text{ or } \textit{vināḍī}.$$

The term *caṣaka* actually occurs in Utpala's works. In his commentary on *Bṛhajjātaka* 7.2, he uses the terms *caṣaka, pala, vikalā* (not *kalā*), and *vighaṭikā* synonymously in the sense of 1/60 of a *ghaṭikā*.[5] Also, in his commentary on *Khaṇḍakhādyaka*, Pūrva 1.20, the term is used as a synonym of *vināḍī*, and is equated to 1/60 of a *nāḍī*. Thus, according to the Sanskrit texts of Utpala,

$$\frac{1}{60}\ \textit{ghaṭikā} \text{ or } \textit{nāḍī} = 1\ \textit{caṣaka} \text{ or } \textit{pala} \text{ or } \textit{vikalā} \text{ or } \textit{vighaṭikā} \text{ or } \textit{vināḍī}.$$

3 Kaye 1927/33, 24–25; Datta 1929a, 41–43.
4 Al-Bīrūnī, *India*, trans., Part 1, 334–337.
5 Cf. also Utpala's commentary on *Bṛhajjātaka* 1.19 and 7.12.

The term *caṣaka* meaning 1/60 of a *ghaṭikā* (or *nāḍikā*) occurs also in the anonymous commentary on Śrīdhara's *Pāṭīgaṇita*, the unique manuscript of which has been discovered in Jammu (near Kashmir). The commentator uses the term *caṣaka* exclusively for the unit equivalent to 1/60 of a *ghaṭikā*.[6]

The *caṣaka* is practically the smallest unit of time in the mathematical and astronomical computations carried out by Utpala and the anonymous commentator of the *Pāṭīgaṇita*. According to the latter, even the *caṣaka* is too minute for practical use, and so it has not been included in Śrīdhara's table of time measures:

> *sūkṣmeṇa caṣakādimānema sthūlena yugādimānena ca lokavyavahāro nāsti. sa iha noktaḥ.*[7]
>
> There is no worldly business by means of small units beginning with the *caṣaka* and of large units beginning with the *yuga*. They are (lit. 'it is'), ⟨therefore⟩, not stated here.

The *Lokaprakāśa* of Kṣemendra, a Kashmirian writer of the eleventh century,[8] gives a definition of *caṣaka*. The passage runs thus:

> *atha kālakalanā kathyate.*
> *ādyakṣaraṃ samuccārya tāvac ca nimiṣaḥ smṛtaḥ,*
> *nimiṣadvayena tuṭir lavaḥ syāt tuṭikādvayam /1/*
> *ṣaṣṭis tu caṣakāś caiva ghaṭikā samudāhṛtā,*
> *ghaṭikādvayasaṃbhūto muhūrtaḥ syāt tathaiva ca /2/*
> *triṃśanmuhūrtakaṃ caivam ahorātram udāhṛtam,*
> *pañcadaśa hy ahorātrāṇy āhuḥ pakṣaṃ sitāsitam /3/*
> *pakṣadvayena māsas tu ṛtur māsadvayena tu,*
> *ṛtutrayeṇāyanaṃ syāt saṃvatsaro 'yanadvayam /4/*[9]
>
> Now, the measurement of time is stated. When one has uttered a syllable like *a*, so much ⟨duration of time⟩ is said to be one *nimiṣa*. Two *nimiṣas* make one *tuṭi*, and two *tuṭikās* one *lava*. ⟨lacuna?⟩ Sixty *caṣakas* are said to be one *ghaṭikā*, and one *muhūrta* is composed of two *ghaṭikās*. Thirty *muhūrtakas* are said to be one *ahorātra* (day and night), and fifteen *ahorātras* are said to be one *pakṣa*, white and black. Two *pakṣas* make one *māsa* (month), two *māsas* one *ṛtu* (season), three *ṛtus* one *ayana* (way ⟨of the sun going from one solstice to another⟩), and two *ayanas* one *saṃvatsara* (year).

The measures of time given in the above four stanzas are summarized in Tables 12.2 and 12.3. The text continues the definitions of the ordinay time-units up to the *manvantara* (Period of Manu) as shown in Table 12.4.[10]

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6 Anon. comm. on *Pāṭīgaṇita* 13, 41, Ex. 60cd, and Ex. 81–82.
7 Anon. comm. on *Pāṭīgaṇita* 13.
8 The *Lokaprakāśa* in its present form contains interpolations as late as the seventeenth century. See Weber 1898, 292.
9 Kṣemendra, *Lokaprakāśa*, p. 74.
10 Kṣemendra, *Lokaprakāśa*, p. 75, stanzas 5–7.

Table 12.2: Minute Measures of Time in the *Lokaprakāśa*

	nimiṣa	*tuṭi*	*lava*
nimiṣa[11]	1		
tuṭi/tuṭikā	2	1	
lava	4	2	1

Table 12.3: Medial Measures of Time in the *Lokaprakāśa*

	ca	*gha*	*mu*	*aho*	*pa*	*mā*	*ṛtu*	*aya*	*saṃ*
caṣaka[12]	1								
ghaṭikā	60	1							
muhūrta	$2 \cdot 60$	2	1						
ahorātra	60^2	60	30	1					
pakṣa				15	1				
māsa				30	2	1			
ṛtu				60	4	2	1		
ayana				180	12	6	3	1	
saṃvatsara				360	24	12	6	2	1

Table 12.4: Large Measures of Time in the *Lokaprakāśa*

	saṃ	*kali*	*dvā-*	*tre-*	*kṛta*	*catur-*	*manu*
saṃvatsara	1						
kaliyuga	432000	1					
dvāparayuga	864000	2	1				
tretāyuga	1296000	3	$\frac{3}{2}$	1			
kṛtayuga	1728000	4	2	$\frac{4}{3}$	1		
caturyuga	4320000	10	5	$\frac{10}{3}$	$\frac{5}{2}$	1	
manvantara	306720000	710	355	$\frac{710}{3}$	$\frac{355}{2}$	71	1

Remark 3

Liptā (Gr. λεπτόν) and *viliptā*. Usually in Indian mathematical and astronomical works, these terms are used for subdivisions of one degree of arc.[13] I can refer only to the *liptā* of Sphujidhvaja's *Yavanajātaka* (A.D. 269/270), where one *liptā* is equated to 1/60 of a *nāḍikā*, or $1/60^2$ of a day (Table 12.5).[14] Hence,

1 *liptā* of the *Yavanajātaka* = 60 *liptās* of the BM.

11 Time required for pronouncing a short syllable like the vowel *a*.
12 The relationship between the *caṣaka* and the minute measures of Table 12.2 is not known.
13 See Sec. 12.2 below.
14 Sphujidhvaja, *Yavanajātaka* 79.28–29. Cf. Shukla 1989, 211–213.

Table 12.5: Measures of Time in the *Yavanajātaka*

	ni	*li*	*ka*	*nā*	*mu*	*dyu*
nimiṣa	1					
liptā	$131\frac{2}{3}$	1				
kalā	790	6	1			
nāḍikā	7900	60	10	1		
muhūrta	15800	2·60	20	2	1	
dyuniśā[15]	474000	60^2	10·60	60	30	1

12.2 Measures of Arc

Units of arc found in the text

⟨30⟩	*bhāgas*	=	1	*rāśi*	X 16
60	*viliptās*	=	1	*liptā*	X 16
108000	*viliptās*	=	1	*rāśi*	X 16

Table 12.6: Measures of Arc in the *Bakhshālī Manuscript*

	viliptā	*liptā*	*bhāga*	*rāśi*
viliptā	1			
liptā	60	1		
bhāga	60^2	60	1	
rāśi	108000	1800	30	1

Remark

These measures of arc are rarely used in purely mathematical works, although they are common in astronomical works. It will be observed that the above relations, together with '12 *rāśis* = 1 *bhagaṇa* (zodiac)', exactly correspond to those of the time measures from *caṣaka* to *varṣa* as shown in Table 12.7. A similar correspondence between time and arc is recognized in Indian astronomy since at least the fifth century A.D.[16]

Table 12.7: Arc-Time Relation in the *Bakhshālī Manuscript*

ARC					TIME				
60	*viliptās*	=	1	*liptā*	60	*caṣakas*	=	1	*ghaṭikā*
60	*liptās*	=	1	*bhāga*	60	*ghaṭikās*	=	1	*dina*
30	*bhāgas*	=	1	*rāśi*	30	*dinas*	=	1	*māsa*
⟨12	*rāśis*	=	1	*bhagaṇa*⟩	12	*māsas*	=	1	*varṣa*

15 A nychthemeron.
16 Āryabhaṭa, *Āryabhaṭīya*, 3.1–2.

12.3 Measures of Length

Units of length found in the text

24	*aṅgulas*	=	1	*hasta*	X 6, 7, 10
768000	*aṅgulas*	=	1	*yojana*	X 10
8	*krośas*	=	1	*yojana*	X 10, 14
⟨4⟩	*gadyūtis*	=	1	*yojana*	III 23
8000	*dhanus*	=	1	*yojana*	X 9
4608000	*yavas*	=	1	*yojana*	X 12
4000	*hastas*	=	1	*krośa*	X 10

Table 12.8: Measures of Length in the *Bakhshālī Manuscript*

	ya	*aṅ*	*ha*	*dha*	*kro*	*ga*	*yo*
yava	1						
aṅgula	6	1					
hasta	144	24	1				
dhanus	576	96	4	1			
krośa	576000	96000	4000	1000	1		
gadyūti	1152000	192000	8000	2000	2	1	
yojana	4608000	768000	32000	8000	8	4	1

Remark 1

6 *yavas* = 1 *aṅgula*. The commonest ratio of the *aṅgula* (digit) to the *yava* (barley corn) in Hindu and Jaina works is eight to one, and this ratio is, in most of those works, also applied successively to the theoretical (or conventional) units smaller than the *yava*.[17] In Buddhist works, the ratio, 7:1, is common.[18]

The relation, 6 *yavas* = 1 *aṅgula*, is not very common, but it does occur in the mathematical text of Śrīpati (A.D. 1039/56):

aṅgulaṃ ṣaḍyavair nistuṣair jāyate.[19]

The *aṅgula* is produced by six *yavas* (barley corns) having no husks.

The younger Āryabhaṭa (10th century) gives the circumference of the earth in *yojanas* based on the *aṅgula* of 6 *yavas*:

ṣaṭyavāṅgulamānena kṣitiparidhir bhavati yojanair madhyaḥ,
cetaramai pūrvāpara uttarayāmyo 'tha vā tāvān.[20]

17 Cf. Kirfel 1920, 331–332 and 337, and Srinivasan 1979, 8. See also *Līlāvatī* 5, *Gaṇitasārasaṃgraha*, saṃjñā 26–27, and *Bṛhatsaṃhitā* 57.1–2. K. M. Banerjea's edition of the *Mārkaṇḍeyapurāṇa* (48.37–38) has 11 instead of 8, and so also does Kirfel 1927, IIB,5,69–70 (p. 89). The ratio, 10:1, is referred to as that of the *Mārkaṇḍeyapurāṇa* by Wilson 1840, 40, fn. 6.

18 Kirfel 1920, 335–336, and Srinivasan 1979, 8. See also Vasubandhu, *Abhidharmakośa* 3.85–86.

19 Śrīpati, *Gaṇitatilaka* 8.

20 Āryabhaṭa, *Mahāsiddhānta* 1.56.

> The east-west circumference of the earth at its center is 6625 *yojanas*, according to the measure where 6 *yavas* ⟨make⟩ one *aṅgula*. The north-south ⟨circumference is also⟩ the same.[21]

Here, the syllable *ta* in *tayava* stands for the number 6 according to the *Kaṭapayādi* system of numbers used by him.[22]

Śārṅgadeva (13th century), while describing musical instruments, employs the ratio, 6:1, of the *aṅgula* to the *yava*:

> *tiryagyavodaraiḥ ṣaḍbhir nistuṣaiḥ syād ihāṅgulam.*[23]
>
> Bellies of six *yavas* having no husks, ⟨arranged⟩ side by side, make the *aṅgula* here.

He says later in the same work that the *aṅgula* of 6 *yavas* has been established 'from mathematical literature.'

> *aṅgulaṃ nibabandhāsau siddhaṃ gaṇitaśāstrataḥ,*
> *na hy aṅgulaṃ pañcayavaṃ dṛśyate śāstralokayoḥ,*
> *aṅgulaṃ nistuṣaiḥ ṣaḍbhis tiryagbhiḥ syād yavodaraiḥ.*[24]
>
> He formed the *aṅgula* from the one that has been established from mathematical literature, since the *aṅgula* of five *yavas* is observed neither in scholarly literature nor in worldly business.[25] Bellies of six *yavas* having no husks, ⟨arranged⟩ side by side, make the *aṅgula*.

Karka (before A.D. 1260/70) and Mahīdhara (A.D. 1585/99), at the ends of their respective commentaries on *Kātyāyanaśulbasūtra*, kaṇḍikā 6, cite about forty Śloka stanzas including definitions of linear measures, among which we find the relation, 6 *yavas* = 1 *aṅgula*:

> *aṅgulasya pramāṇaṃ tu ṣaḍyavāḥ pārśvasaṃsthitāḥ.*[26]
>
> The size of an *aṅgula* is six *yavas* arranged side by side.

According to Bhojarāja (A.D. 1005/55), architects used three kinds of *aṅgulas*, that is, *jyeṣṭha* (large), *madhya* (middle), and *kaniṣṭha* (small), which were equated respectively to 8, 7, and 6 *yavas*.[27] Accordingly, there were three kinds of *hasta*-rulers, and one of them was chosen according to the object to be measured.[28]

Remark 2

4 *gadyūtis* = 1 *yojana*. The conversion ratio, 4:1, has been restored from the context (III 23), where a certain man is supposed to drink one *prastha* out of one *āḍhaka* (= 4 *prastha*) of honey-water every time he accomplishes one *gadyūti* of progress for a total distance of, probably, one *yojana*.

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21 Trans. by Sarma 1966, Part 2, 38.
22 Āryabhaṭa, *Mahāsiddhānta* 1.2.
23 Śārṅgadeva, *Saṅgītaratnākara* 6.280. Cf. Shamasastry 1913.
24 Śārṅgadeva, *Saṅgītaratnākara* 6.525cd–526.
25 The ratio, 5:1, which is rejected here, actually occurs in the *Śukranītisāra*, according to Srinivasan 1979, 9.
26 Stanza 24cd of Karka's version, and stanza 31ab of Mahīdhara's.
27 Bhojarāja, *Samarāṅgaṇasūtradhāra* 9.4–5.
28 Bhojarāja, *Samarāṅgaṇasūtradhāra* 9.27cd–39.

The term *gadyūti* (usually *gavyūti* or *gavyūta*; *gāvuta* of the Buddhists and *gāua* of the Jainas) rarely occurs in mathematical works, which usually give the relations:[29]

$$2000 \ \textit{daṇḍas} = 1 \ \textit{krośa},$$

where 4 *hastas* = 1 *daṇḍa*, and

$$4 \ \textit{krośas} = 1 \ \textit{yojana}.$$

The term, however, frequently occurs in the Purāṇas and Jaina works,[30] where

$$2000 \ \textit{daṇḍas} \ (\text{or } \textit{dhanus's}) = 1 \ \textit{gavyūti}$$

$$4 \ \textit{gavyūtis} = 1 \ \textit{yojana},$$

and some texts add the relation:[31]

$$1000 \ \textit{dhanus's} = 1 \ \textit{krośa}$$

or

$$2 \ \textit{krośas} = 1 \ \textit{gavyūti}.$$

Kaye's restoration of the Bakhshālī relation seems to have been:[32]

$$2 \ \textit{gadyūtis} = 1 \ \textit{yojana}.$$

12.4 Measures of Capacity

Units of capacity found in the text

For meat(?):					
32 or 64	*maṇḍalakas/maṇaleās*	=	1	*ṭalla/ṭala/ṭallikā*	V 6

Remark 1

Kuḍava, prastha, etc. The measures *kuḍava, prastha, āḍhaka, droṇa,* and *khārī*, which are regarded as measures of capacity by some authorities,[33] are most probably used as weight measures in the BM. This is strongly suggested by tha fact that the genuine weights, *māṣa* and *siddhārtha*, are used along with the *kuḍava* (abbreviated *ku*) in the description of the weight of a diamond (X 14).

That the use of these units, *kuḍava, prastha,* etc., was not confined to grain and liquids in me-

29 *Pāṭīgaṇita* 12; *Gaṇitasārasaṃgraha*, saṃjñā 30–31; *Līlāvatī* 5–6; and *Gaṇitatilaka* 9. According to *Gaṇitakaumudī*, paribhāṣā 6–7, 4 *krośas* = 1 *yojana*, but 1 *krośa* = 108 *daṇḍas* of 10 *hastas* each = 1080 *hastas*.
30 Kirfel 1920, 332 and 337.
31 *Vāyupurāṇa* 101.126–127; Bhojarāja, *Samarāṅgaṇasūtradhāra* 9.46–47.
32 Kaye 1927/33, 61.
33 The Māgadha *khārikā* is defined by Bhāskara (*Līlāvatī* 7) as one cubic *hasta*. Śārṅgadhara gives the dimensions of a measure cup for the *kuḍava* (*Śārṅgadharasaṃhitā* 1.35; cf. Colebrooke 1817, 3, fn. 2). Kauṭilya (*Arthaśāstra* 2.19.34–35) describes a measure cup having a crest (*śikhā*) in connection with the measures *kuḍava, prastha*, etc.

dieval Kashmir is clearly shown by the statement of Kalhaṇa (ca. A.D. 1150) that King Lalitāditya (A.D. 724–760) made a large statue of the Buddha 'with many thousands of *prasthas* of copper':

> *rītiprasthasahasrais tu tena tāvadbhir eva saḥ,*
> *vyomavyāpī vapuḥ śrīmān bṛhadbuddho vyadhīyata.*[34]
>
> With many thousands of *prasthas* of copper, with such an amount, that great Buddha, sky-pervading, handsome, and dignified, was constructed by him.

Here, the *prastha* is evidently used as a weight measure. In parallel passages immediately preceding the one cited above, Kalhaṇa employs the genuine weight measures, *tolaka* and *pala*, for gold and silver respectiely. Also, al-Bīrūnī (ca. A.D. 1030) has recorded *pala, kuḍava, prastha, āḍhaka, droṇa,* and *khārī* as measures of weight.[35]

In fact, these units were used for weight in Kashmir and the neighbouring districts until quite recent times. According to Stein, *khārī* was the standard measure of weight in Kashmir in the last century.[36] His observation perfectly agrees with an official report presented by R. Strachey, which runs thus:

> Measures of capacity are hardly known in Northern India. In Bengal and Southern India they are more frequently used, and, as a rule, are intended to be equivalent to certain determinate weights of grain.[37]

Remark 2

Maṇḍalaka and *ṭalla*. The only measures that might be used for capacity in the BM are *maṇḍalaka* (or *maṇaleā*) and *ṭalla* (or *ṭala* or *ṭallikā*). The term *maṇḍalaka* is directly attached to the volume 6210 obtained from multiplication of three dimensions, although the linear measure (D) here used is not known; that is,

$$1 \textit{ maṇḍalaka} = 1 \text{ cubic D.}$$

It is, however, very likely that these units too were weight measures, and in that case the equation just given would simply indicate that the unit of volume in measure D corresponds to the weight of one *maṇḍalaka* for the thing treated in the problem (probably meat). It is interesting that a weight called *maṇḍalaa* occurs in *Aṇuogaddārāiṃ* 328, where

$$1 \textit{ maṇḍalaa} = 12 \textit{ kammamāsaas} = 60 \textit{ guñjās } (= 1 \textit{ tola} \text{ of the BM}).$$

As for *ṭalla*, I can only refer to the *collikā*, a measure of load, of the Rajor inscription,[38] but the relation is doubtful.

34 Kalhaṇa, *Rājataraṅgiṇī* 4.203.
35 Al-Bīrūnī, *India*, trans., Part 1, 164.
36 Stein 1900, 325.
37 Thomas 1874, 25, fn. 2.
38 Sircar 1966, s.v. *collika/collikā* (p. 75). Cf. Gopal 1965, 67.

12.5 Measures of Money

Monetary units found in the text

4	*aṃ⟨ḍikās⟩*	=	1	*dhāṇa*	X 2, 7
	kākinī	(=		*kākiṇī*)	X 11
6	*drammas*	=	1	*vajjara*	X 3
12	*dhāṇas*	=	1	*dīnāra*	X 2, 7
2	*dhānakas*	=	1	*dramma*	X 3
	paṇa				I 12, VIII 7, 10
27	*pālāhatas*	=	1	*dhānakas*	X 3
	māṣaka(?)				III 15
	rūpaka				III 14, VIII 4, 9, X 25
⟨10⟩	*śve⟨tikā⟩*	=	1	*pālāhata*	X 3
	satera				X 14

Table 12.9: Measures of Money in the *Bakhshālī Manuscript*—System 1

	aṇ	*dhā*	*dī*	*sa*
aṇḍikā	1			
dhāṇa[39]	4	1		
dīnāra	48	12	1	
satera	⟨96⟩	⟨24⟩	⟨2⟩	1

Table 12.10: Measures of Money in the *Bakhshālī Manuscript*—System 2

	śve	*pā*	*dhā*	*dra*	*va*
śvetikā	1				
pālāhata	10	1			
dhānaka	270	27	1		
dramma	540	54	2	1	
vajjara	3240	324	12	6	1

Table 12.11: Measures of Money in the *Bakhshālī Manuscript*—System 3

	śve	*kā*	*pa*
śvetikā	1		
kākiṇī	⟨20⟩	1	
paṇa	⟨80⟩	⟨4⟩	1

39 Also called *māṣaka*?

Remark 1

System 1 (Table 12.9) is closely connected to the measures of weight used in the BM. For the *dīnāra*, see Remark 4 below. The relationships betweeen *satera* and the other measures have been conjectuerd from Mahāvīra's table of weight measures for base metal (*loha*), which has a structure similar to that of the BM. See Sec. 12.6, Remark 6 below.

Remark 2

System 2 (Table 12.10) is used in a single problem in X 3, but the highest denomination, *vajjara* or *vajjaraka* or *vajara*, occurs also in IX 1, 2, and 3. System 2 can be connected with System 1 if the *dhānaka* in the former can be identified with the *dhāṇa* in the latter. This is very likely, because the *dhāṇa* as a weight measure is otherwise called *dhānaka* (X 2); both words, *dhāṇa* and *dhānaka*, are probably corruptions of *dhānya/dhānyaka*.[40] In that case, the *vajjara* would be equivalent to the *dīnāra*. The *śvetikā*, which is usually called *varāṭaka* or *kapardikā* and equated to 1/20 of a *kākiṇī*,[41] occurs in the works of the Kashmirian writers, Bhaṭṭotpala and Kṣemendra.[42] It may be worth noticing that the ratio, 540:1, of the *śvetikā* to the *dramma* is much smaller than the ratio, 1280:1, of the *varāṭaka* (cowries) to the silver *dramma* given by medieval mathematicians.[43]

Remark 3

System 3 (Table 12.11) has been conjectured on the basis of the table of monetary units cited by Utpala (cf. Table 12.12) :

> *viṃśatiḥ śvetikāḥ proktā kākiṇy ekā vicakṣaṇaiḥ,*
> *taccatuṣkaṃ paṇa iti caturthaṃ taccatuṣṭayam,*
> *caturthakacatuṣkaṃ tu purāṇa iti kathyate,*
> *kārṣāpaṇaḥ sa evoktaḥ kvacit tu paṇaviṃśatiḥ.*[44]
>
> Twenty *śvetikās* are said to be one *kākiṇī* by the experts, four of it (the latter) *paṇa*, and four of it (the last) *caturtha* ('one fourth'). Four *caturthakas* are called *purāṇa*. The same is called *kārṣāpaṇa*, but twenty paṇas ⟨make one *kārṣāpaṇa*⟩ in some places.

Table 12.12: Monetary Units Cited by Utpala

	śvetikā	*kākiṇī*	*paṇa*	*caturtha*	*purāṇa*
śvetikā	1				
kākiṇī	20	1			
paṇa	80	4	1		
caturtha	320	16	4	1	
purāṇa[45]	1280	64	16[46]	4	1

40 The weight *dhānyaka*, also called *māṣaka*, is equated to 4 *aṇḍikās* in the *Carakasaṃhitā*. See Sec. 12.6, Remark 7 below.

41 *Pāṭīgaṇita* 9; *Gaṇitatilaka* 4; *Līlāvatī* 2; and *Gaṇitakaumudī*, paribhāṣā 4. Cf. Sircar 1968, 279–288.

42 Utpala on *Bṛhatsaṃhitā* 79.12–13. Kṣemendra, *Samayamātṛkā* 8.80.

43 *Gaṇitatilaka* 4; *Līlāvatī* 2; and *Gaṇitakaumudī*, paribhāṣā 4 (*kapardikā* for *varāṭaka*). Cf. Sircar 1968, 281–282.

44 Utpala on *Bṛhatsaṃhitā* 79.12–13.

45 Also called *kārṣāpaṇa*.

46 Or 20.

Remark 4

Vajjara and *pālāhata* in System 2. Monetary units of these names have not been attested in any other works. The word *vajjara* may have resulted from the crossing of *vajja* and *vajara*. Both forms can be derived from Skt. *vajra* ('a diamond'): *vajja* by assimilation and *vajara* by addition of the medial *a*. The latter form actually occurs once in the BM (IX 3).

As for *pālāhata*, I may suggest its possible connection with a controversial passage of the Kashmirian chronicle, *Rājataraṅgiṇī*, of Kalhaṇa. In the latest edition, the passage runs thus:

> *bhrātrāhatānāṃ prācuryaṃ vinivāryāsamañjasam,*
> *toramāṇena dīnnārāḥ svāhatāḥ saṃpravartitāḥ.*[47]
>
> Having suppressed improper abundance of what have been struck by ⟨his⟩ brother, Toramāṇa issued *dīnnāras* struck by himself.

The coins, which Toramāṇa is said to have suppressed from circulation by his own issue called *dīnnāra*, are here interpreted by the editor as those struck by his brother, King Hiraṇya, mentioned in the immediately preceding stanza, on the basis of the reading of a single manuscript, while the editor mentions in the apparatus four manuscripts which read '*balāhatānāṃ*' instead of '*bhrātrāhatāṇāṃ*,' and two manuscripts which read '*bālāhatānāṃ*.' M. A. Stein accepted the reading '*balāhatānāṃ*,' but suspected that the word was corrupt, suggesting that it might 'hide a designation of the ruler' who struck the coins in question.[48] A. Cunningham, on the other hand, accepted the reading '*bālāhatānāṃ*.' He tried to connect the word *bāla* to the Greek legend, ΒΙΛΟ or ΒΙΓΟ or ΒΟΛΟ, of the copper Kuṣāṇa coins from Mathura and Sankisa, and conjectured the existence of an early Kuṣāṇa king named Bāla.[49]

The *dīnnāra* coins of Toramāṇa mentioned in the above passage have been identified by Stein and Cunningham with the copper coins bearing the legend Toramāṇa written in a type of the Gupta script, which have been found in Kashmir and the neighbouring districts in large quantities; and this Toramāṇa of the existing copper coins has been identified with the king of the White Huns of that name who invaded Sindh and Malwa in the last quarter of the fifth century A.D.[50]

But, as Cunningham and Stein themselves pointed out, some difficulties arise with this theory. Kalhaṇa places his Toramāṇa several centuries after Mihiragula, the son of King Toramāṇa of the White Huns, in his chronological order; and Kalhaṇa describes Toramāṇa not as a ruling king but as a *yuvarāja* (a crown prince) who was imprisoned by his brother, King Hiraṇya, and who died soon after having been set free from prison.[51] Thus the identification of Toramāṇa, brother of King Hiraṇya, is still open to question, but if our *pālāhata* can be related to the above passage of Kalhaṇa, the situation may be improved. It is interesting that most of existing copper coins bearing the legend Toramāṇa weigh from 100 to 120 grains,[52] or from 54.9 to 65.9 *raktis*.[53] This range points to 60 *raktis*, which are 12 *dhāṇas* (or *māṣas*) of the BM, as the average weight of those coins. It is, therefore, not impossible that the *dīnāra* of the BM, which is equated to 12 *dhāṇas* (Table 12.9), is identical with the *dīnnāra* of Toramāṇa referred to in the cited passage of the *Rājataraṅgiṇī*.

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47 Kalhaṇa, *Rājataraṅgiṇī* 3.103, ed. by Vishva Bandhu.

48 Stein, 1900, 319–320.

49 Cunningham 1894a, 190–193.

50 Stein, loc. cit. Cunningham, loc. cit.

51 Kalhaṇa, *Rājataraṅgiṇī* 3.102–122.

52 Cunningham 1894a, 192, and Smith 1906, 267–268.

53 Based on the relation, 1 *rakti* = 1.82 grains, given by Cunningham 1894b, 32. If we use the relation, 1 *rakti* = 1.864 grains, of Kosambi 1981, 31, the range will be from 53.6 to 64.4 *raktis*.

Remark 5

Rūpaka. This term is usually used to denote a coin in general, and the Gupta silver coin in particular, and is said to be the same as *dramma* in the latter case.[54] In the BM also, it is used in the sense of a coin or a monetary unit, but its relative value is uncertain.

12.6 Measures of Weight

Measures of weight found in the text

For liquids:					
16	*kuḍavas*	=	1	*āḍhaka*	III 23
4	*prasthas*	=	1	*āḍhaka*	III 23
For grain:					
4	*āḍhakas*	=	1	*droṇa*	III 26
4	*kuḍavas*	=	1	*prastha*	III 26
	ḍhe⟨?⟩				I 11
⟨720⟩	*prasṛtis*	=	1	*khā*⟨*rī*⟩	X 13
4	*prasthas*	=	1	*āḍhakas*	III 26
For salt:					
2000	*palas*	=	1	*bhāra*	X 11
For diamonds:					
	māṇa				X 14
128	*māśakas*	=	1	*ku*⟨*ḍava*⟩	X 14
40	*siddhārthas*	=	1	*māśaka*	X 14
For gold:					
$6\frac{1}{4}$	*kalās*	=	1	*yava*	X 5, 13
5	*guñjās*	=	1	*dhāṇa*	X 21
5	*tolas*	=	1	⟨*pala*⟩	III 22
8	*tolas*	=	1	*pala*	X 21
6	*dhāṇas*	=	1	*dra*⟨*ṅkṣaṇa/kṣūṇa*⟩	X 5
12	*dhāṇas*	=	1	*tola*	X 21
2000	*palas*	=	1	*bhāra*	X 21
4	*pādas*	=	1	*kalā*	X 5, 13
⟨12⟩	*māśas*	=	1	*tola*	III 22
⟨4⟩	*mūdṛs*	=	1	*pāda*	X 5
$3\frac{1}{5}$	*yavas*	=	1	*guṃjā*	X 21
⟨16⟩	*yavas*	=	1	*dhāṇa*	X 5
192	*yavas*	=	1	*tola*	X 13
For '*mahāśobhana*' (probably gold):					
4	*aṃḍikās*	=	1	*māṣaka*	X 1, 2
⟨6⟩$\frac{1}{4}$	*kalās*	=	1	*yava*	X 1,2

54 Sircar 1966, s.v. *rūpaka*, and Sircar 1968, 78–79, and 299–301.

Measures of weight found in the text (*continued*)

1⟨$\frac{1}{6}$⟩	*kalās*	=	1	*yava*[55]	X 1, 2
7	*tolas*	=	1	*pala*	X 1, 2
12	*māṣas*	=	1	*tola*	X 1, 2
4	*mūdṛs*	=	1	*pāda*	X 1, 2
60	⟨*raktis*⟩	=	1	*tola*	X 1, 2
8	*siddhārthas*	=	1	⟨*rakti*⟩	X 1, 2
For things whose names are missing:					
4	*aṃḍikās*	=	1	*dhāṇa*	X 3, 20
4	*aṃḍikās*	=	1	*dhānaka*	X 2
48	*aṃḍikās*	=	1	*tola*	X 4 (cf. X 3)
$2\frac{1}{2}$	*kalās*	=	1	*siddhārtha*	X 3
$6\frac{1}{4}$	*kalās*	=	1	*yava*	X 20
8	*tolas*	=	1	*pala*	X 20
12	*dhāṇas*	=	1	*tola*	X 3, 20
4	*pādas*	=	1	*kalā*	X 20
33⟨60	*pādas*⟩	=	1	*gha*⟨*ṭaka*⟩	X 8
⟨4800⟩	*pādas*	=	1	*tola*	X 3
	maṇḍa/maṇḍakā				VII 11, 12
12	*māśakas*	=	1	*tola*	X 4
⟨19200⟩	*mūdṛkās*	=	1	*tola*	X 3
$3\frac{1}{5}$	*yavas*	=	1	*rakti*	X 2, 3, 20
192	*yavas*	=	1	*tola*	X 3, 4
$1\frac{1}{4}$	*raktis*	=	1	*aṃḍikā*	X 2, 3
60	*raktis*	=	1	*tola*	X 3
80	*raktis*	=	1	*suvarṇa*	X 5
480	*raktis*	=	1	*pala*	X 20
$2\frac{1}{2}$	*siddhārthas*	=	1	*yava*	X 3
480	*siddhārthas*	=	1	*tola*	X 3

Remark 1

System 1 (Table 12.13). The so-called grain measures (*dhānyamāna*) such as *prasṛti, kuḍava*, etc., have been included in the category of weight for the reason already stated.[56] The double conversion ratios for wet and liquid substances, which were recommended by several authorities,[57] are not used in the BM.

55 '1' is a graphic error for $1\frac{1}{6}$.
56 See Sec. 12.4, Remark 1.
57 *Śārṅgadharasaṃhitā* 1.33–34; Utpala on *Bṛhatsaṃhitā* 54.17–18. Cf. Kauṭilya, *Arthaśāstra* 2.19.34–35.

Table 12.13: Measures of Weight in the *Bakhshālī Manuscript*—System 1

	prasṛti	*kuḍava*	*prastha*	*āḍhaka*	*droṇa*	*khārī*
prasṛti	1					
kuḍava		1				
prastha		4	1			
āḍhaka		4^2	4	1		
droṇa		4^3	4^2	4	1	
khārī	720					1

Remark 2

720 *prasṛtis* = 1 *khārī* in System 1. The mutual change ratios of *kuḍava, prastha, āḍhaka,* and *droṇa* used in the BM were very popular in ancient and medieval India.[58] However, the ratio of *kuḍava* to *prasṛti* and that of *khārī* to *droṇa* do not seem to have been well settled: the former ratio was 2:1 in the popular Māgadha system of weight,[59] but it is stated to be 8:1 in *Aṇuogaddārāiṃ* 318. Likewise, the relation, 16 *droṇas* = 1 *khārī*, was widely accepted,[60] but Caraka gives the realtion, 4 *droṇas* = 1 *khārī*,[61] and the authority cited by Kṣīrasvāmin, 3 *droṇas* = 1 *khārī*.[62] From these, we can infer at least three different relations between the *prasṛti* and the *khārī*.

a)	2048	*prasṛtis*	=	1	*khārī*	according to Śārṅgadhara
b)	1024	*prasṛtis*	=	1	*khārī*	according to Caraka
c)	768	*prasṛtis*	=	1	*khārī*	according to the authority cited by Kṣīrasvāmin, with the assumption, 2 *prasṛtis* = 1 *kuḍava* (the table does not contain *prasṛti*)

Remark 3

Unidentified unit. The abbreviation *ḍhe* has not been identified, but it is no doubt a measure for grain, as it is attached to certain amounts of *taṇḍula* (unhusked rice) and *mudga* (kidney beans).

58 Srinivasan 1979, 90–92. See also *Pāṭīgaṇita* 11; *Gaṇitasārasaṃgraha*, saṃjñā 37; *Līlāvatī* 8; Utpala on *Bṛhatsaṃhitā* 54.17–18; and *Aṇuogaddārāiṃ* 318. Cf. *Carakasaṃhitā*, kalpasthāna 12.94–95, where 8 *āḍhakas* = 1 *droṇa*.

59 *Śārṅgadharasaṃhitā* 1.25; *Carakasaṃhitā*, kalpasthāna 12.92.

60 See the works cited above in fn. 58 except the *Aṇuogaddārāiṃ*.

61 *Carakasaṃhitā*, kalpasthāna 12.96.

62 Kṣīrasvāmin, *Amarakośodghāṭana* on *Amarakośa* 2.9.88cd–89ab.

Table 12.14: Measures of Weight in the *Bakhshālī Manuscript*—System 2(a)

	mū	*pā*	*ka*	*si*	*ya*	*ra*	*aṇ*	*dhā*	*dra*	*gha*	*to*
mūdṛ[63]	1										
pāda	4	1									
kalā	16	4	1								
siddhārtha	40	10	$\frac{5}{2}$	1							
yava	100	25	$\frac{25}{4}$	$\frac{5}{2}$	1						
rakti[64]	320	80	20	8	$\frac{16}{5}$	1					
aṇḍikā	400	100	25	10	4	$\frac{5}{4}$	1				
dhāṇa[65]	1600	400	100	40	16	5	4	1			
dra[66]	9600	2400	600	240	96	30	24	6	1		
ghaṭaka	13440	3360	840	336	$\frac{672}{5}$	42	$\frac{168}{5}$	$\frac{42}{5}$	$\frac{7}{5}$	1	
tola	19200	4800	1200	480	192	60	48	12	2	$\frac{10}{7}$	1

Table 12.15: Measures of Weight in the *Bakhshālī Manuscript* — System 2(b)

	ra	*aṇ*	*dhā*	*dra*	*gha*	*to*	*su*	*pa*	*ku*	*bhā*
rakti	1									
aṇḍikā	$\frac{5}{4}$	1								
dhāṇa	5	4	1							
dra	30	24	6	1						
ghaṭaka	42	$\frac{168}{5}$	$\frac{42}{5}$	$\frac{7}{5}$	1					
tola	60	48	12	2	$\frac{10}{7}$	1				
suvarṇa	80	64	16	$\frac{8}{3}$	$\frac{40}{21}$	$\frac{4}{3}$	1			
pala	480	384	96	16	$\frac{80}{7}$	8	6	1		
kuḍava	640	512	128	$\frac{64}{3}$	$\frac{320}{21}$	$\frac{32}{3}$	8	$\frac{4}{3}$	1	
bhāra						16000	12000	2000	1500	1

Remark 4

System 2 (Tables 12.14 and 12.15). It is remarkable that almost all the conversion ratios of the measures of weight for things other than grain and liquid, the ratios which have been either found in the manuscript or restored mathematically from the extant data, can be put together into a single

63 Also called *mūdṛkā*.
64 Also called *guñjā*.
65 Also called *dhānaka, māṣa,* and *māśa*.
66 Abbreviation of, probably, *draṅkṣaṇa* or *drakṣūṇa*. See Remarks 5 and 6.

table (Tables 12.14 and 12.15 combined) without any serious problems. The only exception to this is the ratio between the *pala* and the *tola*. The commonest relation in the BM is: 8 *tolas* = 1 *pala*, which has been adopted in the table; but 5 *tolas* = 1 *pala*, and 7 *tolas* = 1 *pala*, are also used once each. This problem will be discussed in Remark 7 below.

Remark 5

Similarities between System 2 and al-Bīrūnī's table. There is a striking resemblance between System 2 and the table of weights which were current in Panjab while al-Bīrūnī was staying there (ca. A.D. 1030). Ha has recorded the following measures and their conversion ratios:[67]

4	*mūdrs*	=	1	*pāda*
4	*pādas*	=	1	*kalā*
$6\frac{1}{4}$	*kalās*	=	1	*yava*
4	*yavas*	=	1	*aṇḍī*
4	*aṇḍīs*	=	1	*māṣa*
6	*māṣas*	=	1	*draṅkṣaṇa*
2	*draṅkṣaṇas*	=	1	*tola*
$\frac{4}{3}$	*tolas*	=	1	*suvarṇa*
2000	*palas*	=	1	*bhāra*

This table contains most of the weights of System 2 along with exactly the same conversion ratios, except those for *siddhārtha, rakti* (or *guñjā*), *ghaṭaka,* and *kuḍava.*

Remark 6

Similarities between System 2 and Mahāvīra's table. A similar table is given also by Mahāvīra, who wrote his *Gaṇitasārasaṃgraha* in the dominion of the Rāṣṭrakūṭa king, Amoghavarṣa (ca. A.D. 814–880). He gives one table each for grain (*dhānya*), gold (*suvarṇa*), silver (*rajata*), and base metal (*loha*), the last of which is thus:[68]

4	*pāda*	=	1	*kalā*
$6\frac{1}{4}$	*kalās*	=	1	*yava*
4	*yavas*	=	1	*aṃśa* (*aṇḍikā* of BM)
4	*aṃśas*	=	1	*bhāga* (*māṣa* of BM)
6	*bhāgas*	=	1	*drakṣūṇa*
2	*drakṣūṇas*	=	1	*dīnāra* (*tola* of BM)
2	*dīnāras*	=	1	*satera*

He also adds:[69]

200	*palas*	=	1	*tulā*
10	*tulās*	=	1	*bhāra*

---

67 Al-Bīrūnī, *India*, trans., Part 1, 160–161. The ratio, 6:1, of *kalā* and *yava* in Sachau's translation is a mistake. The last relation in this list is stated separately in a curious fashion. He says that it is 'mentioned in the books about the conquest of Sindh' (Part 1, p. 165).

68 Mahāvīra, *Gaṇitasārasaṃgraha*, saṃjñā 42–43.

69 *Gaṇitasārasaṃgraha*, saṃjñā 44.

Hence,

$$2000 \quad \textit{palas} \quad = \quad 1 \quad \textit{bhāra}.$$

This seems to be an instance of cultural and commercial connections between the North and the South in medieval India. Commercial transactions are said to have been maintained between the Rāṣṭrakūṭa kingdom (8th to 10th centuries) and the Arab merchants of Sindh.[70] The *Laghumānasa*, an astronomical work composed by Muñjāla (alias Mañjula) in A.D. 932 at Prakāśa on the Tāpī, was commented upon by the Kashmirian Praśastadhara in A.D. 958;[71] the two extant manuscripts of that commentary are both preserved in Mysore.[72] Bilhaṇa, a Kashmirian poet who traveled all over India, is said to have been patronized by Chālukya Vikramāditya (1076–1126) of Kalyāṇī.[73] Harṣadeva (1089– 1101) of Kashmir is said to have imitated Karṇāṭa coinage:

karṇāṭānuguṇaṣ ṭaṅkas tatas tena pravartitaḥ.[74]

Then, a coin, modeled on a Karṇāṭa ⟨style⟩, was issued by him.

Numismatists have pointed out the influence of the gold coins of Koṅgadeśa (in South India) upon Harṣadeva's existing coins.[75]

Remark 7

Sub-systems of System 2. System 2 has several fractional ratios between consecutive terms. This indicates that the system consists of several sub-systems of different origins. Thus, we find in System 2 two different ways of subdividing the *rakti* (= *guñjā*).

(a)	1	*siddhārtha*				=	$\frac{1}{8}$	*rakti*
(b)	1	*kalā*				=	$\frac{1}{20}$	*rakti*
	1	*pāda*	=	$\frac{1}{4}$	*kalā*	=	$\frac{1}{80}$	*rakti*
	1	*mūdr(kā)*	=	$\frac{1}{4}$	*pāda*	=	$\frac{1}{320}$	*rakti*

From the *rakti* upwards are derived the following two systems:

(c)	1	*māṣa*				=	5	*raktis*
	1	*suvarṇa*	=	16	*māṣas*	=	80	*raktis*
	1	*pala*	=	6	*suvarṇas*	=	480	*raktis*
(d)	1	*ghaṭaka*				=	42	*raktis*

The following table, which seems to have been originally independent of (c), is connected to it through the medium of the *māṣa*.

(e)	1	*aṇḍikā*	=	4	*yavas*
	1	*māṣa*	=	4	*aṇḍikās*
	1	*dra⟨ṅkṣaṇa⟩*	=	6	*māṣas*
	1	*tola*	=	2	*dra⟨ṅkṣaṇas⟩*

70 Smith 1919/1981, 216.
71 Pingree 1981, 34.
72 Pingree, *CESS* A4, 227b.
73 Apte 1957/59, Appendix B, s.v. *bilhaṇa*.
74 Kalhaṇa, *Rājataraṅgiṇī* 7.926cd. Cf. Cunningham 1894b, 34–35.
75 Rapson 1897, 36. Brown 1922, 55.

Note that table (e) does not contain *rakti* or *guñjā*, which was practically the basic standard of most weight systems in India.

The *bhāra* is based on the unit *pala*, and is thereby connected to (c).

(f) 1 *bhāra* = 2000 *palas*

The basic unit comprised in the *kuḍava* is uncertain, but it has integer ratios to the *suvarṇa*, *māṣa*, and *rakti*, which all belong to (c).

(g) 1 *kuḍava* = 8 *suvarṇas* = 128 *māṣas* = 640 *raktis*

— Relation (a). The word *siddhārtha* (a white mustard seed) itself is rarely used for a weight measure, but its synonyms, *gaurasarṣapa*, *sitasarṣapa*, etc. are common. Their conversion ratios are, however, different.

	8	*sitasarṣapas* (white mustard)	=	1	*taṇḍula* (unhusked rice)[76]
	18	*gaurasarṣapas* (white mustard)	=	1	*kṛṣṇala* (= *rakti*)[77]
Cf.					
	8	*raktasarṣapas* (red mustard)	=	1	*taṇḍula* (unhusked rice)[78]
	32	*sarṣapas* (mustard)	=	1	*guñjā* or *raktikā*[79]

— Table (b). The smallest unit *mūdṛ(kā)* of Table (b) has not been attested in any other works. But it may be connected with the *mundri* that occurs in Srinivasan's report: 'In South India the term *mundri* stands for the fraction 1/320.'[80] Our *mūdṛ* is 1/320 of a *rakti*.

— Table (c). This table, with 1 *pala* = 4 *suvarṇas* (= 320 *raktis*), occurs in *Manusmṛti* 8.134, in *Arthaśāstra* 2.19.2–4, in *Amarakośa* 2.9.85–86, in Bhāskara's *Āryabhaṭīyabhāṣya*, pp. 117–118, in *Pāṭīgaṇita* 10, in *Gaṇitasārasaṃgraha*, saṃjñā 39 (*paṇa* for *māṣa*), in Utpala's commentary on *Bṛhatsaṃhitā* 80.13, in *Līlāvatī* 4, and in *Gaṇitakaumudī*, paribhāṣā 5. According to some of these texts, the table is specifically intended for weighing gold.

As has been noted above, the BM uses three kinds of *pala*:

1	*pala*	=	8	*tolas*	=	6	*suvarṇas*	=	480	*raktis*
1	*pala*	=	7	*tolas*	=	5.25	*suvarṇas*	=	420	*raktis*
1	*pala*	=	5	*tolas*	=	3.75	*suvarṇas*	=	300	*raktis*

These ratios themselves have not been found in other Indian works, but the variable nature of the value of the *pala* has been mentioned by several medieval writers (cf. Figure 12.1). The *Yājñavalkyasmṛti* authorizes two values of *pala*.

> *palaṃ suvarṇāś catvāraḥ pañca vāpi prakīrtitam.*[81]
>
> The *pala* is said to be four *suvarṇas* or, otherwise, five *suvarṇas*.

This sentence concludes Yājñavalkya's table of weight measures for gold (Table 12.16). It begins with the *trasareṇu* (a movable dust), which is defined as a particle of dust that can be observed in the sun's ray comming through a net.

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76 *Bṛhatsaṃhitā* 79.12.
77 *Yājñavalkyasmṛti* 1.362–363.
78 *Carakasaṃhitā*, kalpasthāna 12.87, where 2 *taṇḍulas* = 1 *dhānyamāṣa*, and 2 *dhānyamāṣas* = 1 *yava* (barley).
79 *Śārṅgadharasaṃhitā* 1.19, where 8 *sarṣapas* = 1 *yava*, and 4 *yavas* = 1 *guñjā*.
80 Srinivasan 1979, 101.
81 *Yājñavalkyasmṛti* 1.364ab.

Table 12.16: Weight Measures for Gold in the *Yājñavalkyasmṛti*

	tra	*li*	*rā*	*gau*	*ya*	*kṛ*	*mā*	*su*	*pa*
trasareṇu	1								
likṣā	8	1							
rājasarṣapa	24	3	1						
gaurasarṣapa	72	9	3	1					
yava[82]	432	54	18	6	1				
kṛṣṇala	1296	162	54	18	3	1			
māṣa	6480	810	270	90	15	5	1		
suvarṇa						80	16	1	
pala[1]						320	64	4	1
pala[2]						400	80	5	1

The same two values, 4 *suvarṇas* and 5 *suvarṇas*, of the *pala* are employed in an example for the inverse rule of three by Bhāskara, who wrote his commentary of the *Āryabhaṭīya* in A.D. 629 at Valabhī.

> *pañcasauvarṇike pale dṛṣṭāni ṣoḍaśa palāni suvarṇasya yadā*
> *tadā catussauvarṇike kiyantīti.*[83]

> When one *pala* is equivalent to 5 *suvarṇas*, a certain quantity of gold weighs 16 *palas*. What will the same gold weigh when one *pala* is equivalent to 4 *suvarṇas*.[84]

Al-Bīrūnī (ca. A.D. 1030) has recorded four kinds of *pala*.

> The weight *pala* is much used in all the business dealings of the Hindus, but it is different for different wares and in different provinces. According to some, 1 *pala* = 1/15 *manā*; according to others, 1 *pala* = 14 *mithqāl*; ... According to others, 1 *pala* = 16 *mithqāl*, ... According to others, 1 *pala* = 15 *dirhams*, ...[85]

The different values of the *pala* recorded here in terms of the Persian measures can be converted into *suvarṇa* by using the relations given by al-Bīrūnī himself.[86]

1	*pala*	=	16	*mithqāls*	=	5.71	*suvarṇas*
1	*pala*	=	14	*mithqāls*	=	5	*suvarṇas*
1	*pala*	=	15	*dirhams*	=	3.75	*suvarṇas*
1	*pala*	=	$\frac{1}{15}$	*manā*	=	3	*suvarṇas*

The two smaller values of the *pala* used in the BM fall between the greatest and the smallest of the above four values mentioned by al-Bīrūnī; but the commonest relation in the BM,

1 *pala* = 6 *suvarṇas* = 8 *tolas* = 480 *raktis*,

lies outside of that range. For this value, I can only refer to a Gujarātī commentary (14th century) on Śrīdhara's *Pāṭīgaṇita*, which is said to give,[87]

1 *pala* = 20 *dharaṇas* = 160 *vallas* = 480 *raktikās*

82 Of mean size.
83 Bhāskara, *bhāṣya* on *Āryabhaṭīya* 2.26, Ex. 14 (p. 122).
84 Trans. by Shukla 1976, 306.
85 Al-Bīrūnī, *India*, trans., Part 1, 163.
86 Al-Bīrūnī, *India*, trans., Part 1, 160: 3 *suvarṇas* = 4 *tolas* (cf. the Bakhshālī relation, 1 *pala* = 8 *tolas* = 6 *suvarṇas* = 480 *raktis*, listed above), 1 *tola* = 3 *dirhams*, and 10 *dirhams* = 7 *mithqāls*; and p. 164: 1 *manā* = 180 *dirhams*.
87 Srinivasan 1979, 116

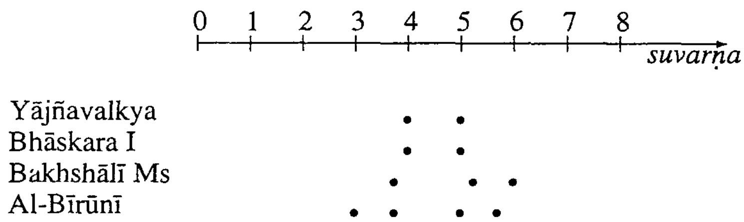


Figure 12.1: Various Values of the *pala*

besides the ordinary one,

1 *pala* = 4 *karṣas* = 64 *māṣas* = 320 *guñjās*.

—Relation (d) occurs in *Līlāvatī* 3, according to which,

3	*guñjās*	=	1	*valla*
14	*vallas*	=	1	*ghaṭaka*

The first equation occurs also in the Kāliṅga system of weights recorded in *Śārṅgadharasaṃhitā* 1.39–42.

—Table (e), with a slight difference in terminology, occurs in *Carakasaṃhitā*, kalpasthāna 12.88–90, accoridng to which,

4	*yavas*	=	1	*aṇḍikā*
4	*aṇḍikās*	=	1	*māṣaka* or *hema* or *dhānyaka*
2	*māṣakas*	=	1	*śāṇa*
2	*śāṇas*	=	1	*draṅkṣaṇa* or *kola* or *badara*
2	*draṅkṣaṇas*	=	1	*karṣa* or *suvarṇa*

Other synonymous terms given for *karṣa* in the *Carakasaṃhitā* are: *akṣa, viḍālapadaka, picu, pāṇitala, tinduka,* and *kavalagraha.*

It is noteworthy that in this table of Caraka one *suvarṇa* (= *karṣa*) is equated to 12 *māṣakas* (= *māṣas*). In the BM, 12 *māṣas* make one *tola* (Table (e)), and 16 *māṣas* one *suvarṇa* (Table (c)). Some later writers use the terms *tola* and *karṣa* (or *suvarṇa*) synonymously, and equate them to 16 *māṣas* or 80 *raktis*.[88] According to the Māgadha system of weights recorded in *Śārṅgadharasaṃhitā* 1.15–35, one *śāṇa* comprises 4 *māṣas*, and one *māṣa* 6 *raktikās*. Hence, 1 *karṣa* (or *suvarṇa*) = 16 *māṣas* = 96 *raktikās*.[89]

A *tola* defined as 12 *māṣas* of 8 *raktis* each is said to have been used in the sixteenth century during the reign of Babur;[90] this *tola* (= 12 *māṣas* = 96 *raktis*) was one of the most basic units of the British Indian weight system.[91] The *tola* of the BM, which is equivalent to 12 *māṣas* or 60 *raktis*, has not been attested as such in any other works,[92] but it is interesting that the same weight is called *lakṣa* by an authority cited by Utpala:[93]

88 See, for example, Yādavaprakāśa's *Vaijayantī* as cited by Sircar 1968, 68. Note that Sircar himself always assumes: 1 *tola* = 1 *karṣa* (or *suvarṇa*).

89 For other ratios of the *karṣa* to the *rakti*, see Sircar 1968, 63, fn. 2.

90 Srinivasan 1979, 106.

91 Prinsep 1858, 95–96.

92 According to Srinivasan 1979, 107, the *tola* of diamonds was 62 *raktis* in Surat and Ahmedabad in the seventeenth century.

93 Utpala on *Bṛhatsaṃhitā* 54.17–18. The printed text has *māṣala* instead of *māṣaka*, but it must be a typographical error.

1	*māṣaka*	=	5	*kṛṣṇalas* (or *raktis*)
1	*lakṣa*	=	12	*māṣakas*
1	*suvarṇa*	=	16	*māṣakas*

—Relation (f) is found in *Amarakośa* 2.9.87, in Bhāskara's *bhāṣya* on the *Āryabhaṭīya* (p. 117), in the quotation by Utpala just mentioned, in *Śārṅgadharasaṃhitā* 1.31, and in *Gaṇitasārasaṃgraha*, saṃjñā 44. Other ratios between *bhāra* and *pala* are also known:

2048	*palas*	=	1	*bhāra*
				Carakasaṃhitā, kalpasthāna 12.93–96, and the authority cited by Kṣīrasvāmin in his *Amarakośodghātana* on *Amarakośa* 2.9.88–89.
2100	*palas*	=	1	*bhāra*
				Aṇuogaddārāiṃ 322.

—The value of the *kuḍava* given in (g) is peculiar to the BM as far as I know. According to *Śārṅgadharasaṃhitā* 1.19–25,

$$1\ \textit{kuḍava} = 4\ \textit{palas} = 16\ \textit{suvarṇas} = 256\ \textit{māṣas} = 1536\ \textit{raktis};$$

according to *Carakasaṃhitā*, kalpasthāna 12.89–93,

$$1\ \textit{kuḍava} = 4\ \textit{palas} = 16\ \textit{suvarṇas} = 192\ \textit{māṣas};$$

and according to *Gaṇitasārasaṃgraha*, saṃjñā 36–44,

$$1\ \textit{kuḍava} = \tfrac{1}{4}\ \textit{prastha} = \tfrac{25}{8}\ \textit{palas} = 1000\ \textit{guñjās}.$$

Thus the commonest relation seems to have been:

$$4\ \textit{palas} = 1\ \textit{kuḍava},$$ [94]

while in the BM,

$$4\ \textit{palas} = 3\ \textit{kuḍavas}.$$

Remark 8

Māṇa. A measure called *māṇa* is employed, along with the *siddhārtha, māṣaka,* and *kuḍava*, for expressing the weight of a diamond (X 14). This may be identical with the *mānaka* of the elder Bhāskara, according to whom,[95]

$$1\ \textit{mānaka} = \tfrac{1}{4}\ \textit{setikā} = \tfrac{1}{16}\ \textit{kuḍava}.$$

Caraka's table of weights contains a heavier weight called *mānikā*, which is equivalent to 2 *kuḍavas* or 384 *māṣas*,[96] while

$$1\ \textit{mānikā} = 2\ \textit{kuḍavas} = 512\ \textit{māṣas} = 3072\ \textit{raktikās}$$

according to *Śārṅgadharasaṃhitā* 1.19–26. Still heavier than these is a weight called *mānikā* or *mānī* which is equated to 4 *droṇas* or 256 *kuḍavas*,[97] though these would be too heavy for a diamond.

94 For this relation, see also Utpala on *Bṛhatsaṃhitā* 54.17–18, Kṣīrasvāmin on *Amarakośa* 2.9.88–89, and the *Aṣṭāṅgahṛdaya* as cited by Sircar 1968, 72.

95 Bhāskara, *bhāṣya* on the *Āryabhaṭīya*, pp. 121–122. Cf. *Gaṇitatilaka* 7, where 4 *mānakas* = 1 *setikā*.

96 *Carakasaṃhitā*, kalpasthāna 12.88–93.

97 *Gaṇitasārasaṃgraha*, saṃjñā 36–37, and Utpala on *Bṛhatsaṃhitā* 54.17–18.

Remark 9

Maṇḍa. A measure called *maṇḍa(kā)* occurs in two examples of the so-called Hundred Hens Problem (VII 11, 12). This may be related to the weight *maṇḍa* of Yādavaprakāśa, acccording to whom 1 *maṇḍa* = 5 *māṣas*, where one *māṣa* comprises 7 *guñjās* for base metal, 5 *guñjās* for gold, and 2 *guñjās* for silver.[98] Another weight of the same name, which is equal to 5 *māṣas* of 10 *raktis* each, is said to occur in inscriptions.[99] The possibility, however, cannot be denied that our *maṇḍa* is a monetary unit, as the Hundred Hens Problem usually involves the prices of living creatures. It is said that in Telugu the term *māḍa* stands for a gold or silver coin of 40 *raktis* in weight.[100]

12.7 Unidentified Abbreviations for Measures

9	*gu*⟨?⟩	=	1	*va*⟨?⟩ or *vā*⟨?⟩	X 7
	ḍhe⟨?⟩			(for grain)	I 11
3	*tṛ*⟨?⟩	=	1	*ā*⟨?⟩	X 17

Remark

Kaye suggests *guñjā* for '*gu*,' and *valla* for '*va*,'[101] but the relation, 9 *guñjās* = 1 *valla*, does not agree with the weight system of the BM. The abbreviation '*tṛ*' may simply stand for *tṛtīya(ka)* or 'a third.'

98 Yādavaprakāśa, *Vaijayantī* as cited by Sircar 1968, 67.
99 Sircar 1966, s.v. *maṇḍa*.
100 Sircar 1966, s.v. *māḍa*.
101 Kaye 1927/33, 64.

CHAPTER 13

Sources of the Bakhshālī Manuscript

13.1 The So-Called Direct Western Influence

Kaye gives two instances in support of his theory of direct Western influence upon the BM. He says:

> Now in the Bakhshālī Manuscript is an example of the transformation of a simple fraction expressed in the ordinary way to the sexagesimal notation. This transformation may be represented by
>
> $$\frac{178}{29} = 6 + 8' + 16'' + 33^{iii} + 6^{iv}\frac{6}{29}$$
>
> No such example occurs in any early Hindu work and there is not the slightest doubt that it indicates direct western influence.[1]

As has been pointed out by Datta,[2] Kaye's presentation of the problem is totally misleading. The actual problem in this case (Ex. 2 for Sūtra 19) is not to transform a simple fraction to a sexagesimal fraction, but to express a fractional portion of a day in its sub-measures:

$\frac{178}{29}$ days = 6 days + 8 *ghaṭikās* + 16 *caṣakas* + 33 *liptās* + $6\frac{6}{29}$ *viliptās*,

where each of the sub-units is equivalent to 1/60 of the preceding one.

It is certain that the sexagesimal notation itself originated in Mesopotamia, but it had already arrived in India by the early centuries of the Christian era. Āryabhaṭa (A.D. 499), for example, defines sub-units of a day thus:[3]

1	day	=	60	*nāḍīs*
1	*nāḍī*	=	60	*vināḍikās*
1	*vināḍikā*	=	60	heavy syllables
		=	6	*prāṇas* (breaths)

The introduction of the *prāṇa* into this table has an astronomical meaning; that is, according to Āryabhaṭa, the earth rotates by one *kalā* (minute) of arc for one *prāṇa* of time.[4] The table is, however, complete without it, and is wholly sexagesimal in so far as the subdivisions of a day are concerned.

1 Kaye 1927/33, 73.
2 Datta 1929a, 41–43.
3 *Āryabhaṭīya* 3.1–2.
4 *Āryabhaṭīya* 1.6.

Moreover, the sexagesimal system for time-divisions is found used in Chapter 79 of Sphujidhvaja's *Yavanajātaka* (A.D. 279/280).[5] We, therefore, do not have to look for the origin of the Bakhshālī method of time-division in Western civilizations if, for argument, we assume the Bakhshālī work was composed later than the third century A.D.[6]

Another point of Kaye's arguments about the sexagesimal notation is this:

> . . . the Indians, although they adopted the western sexagesimal notation for astronomical purposes, did not utilize this notation for purposes of arithmetical calculation.[7]

This statement is also misleading because we know that the sexagesimally defined measures of time, *ghaṭikā* and *caṣaka*, are actually used in arithmetical calculation in the anonymous commentary on Śrīdhara's *Pāṭīgaṇita*. Moreover, the same two measures are clearly defined even in the non-mathematical work, *Lokaprakāśa* of Kṣemendra.[8]

Another bit of 'evidence' that Kaye regards as showing direct Western influence is the root-approximation formula (Sūtra Q2). He says:

> It occurs in many western works from the time of Heron onwards but it occurs in no Indian work earlier than the twelfth century: indeed the earliest record of this method in an Indian work (other than Bakhshālī Manuscript) known to me is of the 16th century.[9]

We cannot agree with Kaye as his arguments here are based on his insufficient knowledge about the history of root-approximation formulas in India.[10] Moreover, that the earliest record of the formula in an Indian work (other than the BM) is of the 16th century, if this be a fact, does not necessarily imply the existence of the direct foreign influence upon the Bakhshālī formula for root-approximation.

I have not so far been able to find any evidence to show 'direct' Western influence upon the Bakhshālī work.

13.2 Non-Mathematical Works

13.2.1 The Mahābhārata

Ex. 42 for Sūtra C10, which is concerned with the size of an army called *akṣauhiṇī*, is a verbatim quotation from *Mahābhārata* 1 (ādiparvan).2.15–19a. Moreover, its solution is nothing but a mathematical elucidation of the four stanzas that immediately follow the cited stanzas. The passage in question runs thus:

> *ṛṣaya ūcuḥ.*
> *akṣauhiṇya iti proktaṃ yat tvayā sūtanandana,*
> *etad icchāmahe śrotuṃ sarvam eva yathātatham /13/*
> *akṣauhiṇyāḥ parīmāṇaṃ rathāśvanaradantinām,*
> *yathāvac caiva no brūhi sarvaṃ hi viditaṃ tava /14/*
> *sūta uvāca.*

5 See Sec. 12.1, Remark 3 and Table 12.5 above.
6 Kaye 1927/33, 84, assigns the Bakhshālī work as well as the manuscript to the twelfth century.
7 Kaye 1927/33, 73.
8 See Sec. 12.1, Remark 2 above.
9 Kaye 1927/33, 73.
10 See Chap. 11 above.

(Cited stanzas)[11]
akṣauhiṇyāḥ prasaṃkhyānaṃ rathānāṃ dvijasattamāḥ,
saṃkhyāgaṇitatattvajñaiḥ sahasrāṇy ekaviṃśatiḥ /19/
śatāny upari caivāṣṭau tathā bhūyaś ca saptatiḥ,
gajānāṃ tu parīmāṇam etad evātra nirdiśet /20/
jñeyaṃ śatasahasraṃ tu sahasrāṇi tathā nava,
narāṇām api pañcāśac chatāni trīṇi cānaghāḥ /21/
pañcaṣaṣṭisahasrāṇi tathāśvānāṃ śatāni ca,
daśottarāṇi ṣaṭ prāhur yathāvad iha saṃkhyayā /22/
etām akṣauhiṇīṃ prāhuḥ saṃkhyātattvavido janāḥ,
yāṃ vaḥ kathitavān asmi vistareṇa dvijottamāḥ /23/

The seers said:
Son of the Bard, you spoke of "armies" (*akṣauhiṇīs*). We wish to learn exactly what the strength of an "army" (*akṣauhiṇī*) is, in men, chariots, horses, and elephants. Tell it to us precisely, for you know everything!
The Bard said:
(Cited stanzas)[12]
The number of chariots in one army (*akṣauhiṇī*), good brahmins, has been calculated by those familiar with arithmetic as 21,870. The strength in elephants is the same, while footmen number 109,350 and the horses 65,610. This is what those who know how to reckon with figures call an "army" (*akṣauhiṇī*), which I have now fully explained to you, eminent brahmins.[13]

Ex. 42 for Sūtra C10, which consists of stanzas 15 to 19a of the *Mahābhārata*, successively gives the sizes of the armies from *patti* to *akṣauhiṇī*:

1	*patti*	=	1 *ratha* (chariot) + 1 *gaja* (elephant) + 5 *padātis* (foot soldiers) + 3 *turagas* (horses)
3	*pattis*	=	1 *senāmukha*
3	*senāmukhas*	=	1 *gulma*
	...		...
3	*camūs*	=	1 *anīkinī*
10	*anīkinīs*	=	1 *akṣauhiṇī*

Then comes, in the BM, the computation of the number of each category contained in one *akṣauhiṇī*. Then, the answer is given in tabular form:

21870	*rathas*
21870	*gajas*
109350	*naras* ('men' or foot soldiers)
65610	*hayas* (horses)

The terminology used in this answer is worth noticing: while the words used for denoting the first three categories are the same both in this answer and in the corresponding stanzas (19, 20, and 21) of the *Mahābhārata*, that for the last category, horse, is *haya* in the BM, and *aśva* in stanza 22 of the *Mahābhārata*. One might suggest an alternative reading for *Mahābhārata* 1.2.22b (for example,

11 The citation is up to the first *pāda* of stanza 19.
12 See X 22–23 in Part 3 (Translation) below.
13 Trans. by Buitenen 1973, 32–33. I have supplied '*akṣauhiṇī*' in parentheses.

hayānāṃ tu śatāni ca), but the critical edition by Sukthankar does not mention any variant reading for that *pāda*. I suspect that the author of Ex. 42 for Sūtra C10 may have used a copy of one of the lost recensions.[14]

The names of epic heroes occur in several examples of the BM. Ex. 27 for Sūtra C10 is a problem of the arrows shot by Arjuna, the third Pāṇḍava prince, who is famous for his skill in archery. The same motif is utilized by Bhāskara in an example for *guṇakarman* ('the computation with a multiplier ⟨of the square root⟩').[15] Yudhiṣṭhira, the first Pāṇḍava prince, is the character of Ex. 33 for Sūtra C10, although nothing about its mathematical purport is known. Ex. 41 for the same *sūtra*, which asks about the number of the arrows required for destroying four *akṣauhiṇīs* of an army, contains the names of Pārtha (= Arjuna), Hehaya (= Haihaya, Arjuna Kārtavīrya), and (?) Kīcakanighna (= Bhīma, the second Pāṇḍava prince), though the intended situation of the problem is not clear to me.

There are several expressions in the BM which seem to be a sort of 'stock phrases' common to the epic and the BM. Compare the phrases of the BM,

> *etan me saṃśayaṃ prājña* (Ex. 14 for Sūtra 25, III 29)
> *tato me cchindhi saṃśayaḥ* (Ex. 1 for Sūtra 13, III 5)

with the following phrase of the *Mahābhārata*:

> *etan me saṃśayaṃ chinddhi* (12.137.3a and 12.336.7c)
>
> Remove this doubt of mine.

13.2.2 The Rāmāyaṇa

Ex. 16 for Sūtra C10 asks about the number of 'turning-backs' (*parāvarta*) made by the garment (*vastra*) that was thrown by Sītā from the sky. This problem is based on the episode of Sītā's abduction by Rāvaṇa told in *Rāmāyaṇa* 3 (araṇyakāṇḍa).52.1–5.

> *hriyamāṇā tu vaidehī kaṃcin nātham apaśyatī,*
> *dadarśa giriśṛṅgasthān pañca vānarapuṃgavān /1/*
> *teṣāṃ madhye viśālākṣī kauśeyaṃ kanakaprabham,*
> *uttarīyaṃ varārohā śubhāny ābharaṇāni ca /2/*
> *mumoca yadi rāmāya śaṃseyur iti bhāminī,*
> *vastram utsṛjya tanmadhye nikṣiptaṃ sahabhūṣaṇam /3/*
> *saṃbhramāt tu daśagrīvas tatkarma ca na buddhavān,*
> *piṅgākṣās tāṃ viśālākṣīṃ netrair animiṣair iva /4/*
> *vikrośantīṃ tadā sītāṃ dadṛśur vānarottamāḥ /5ab/*
>
> The princess of Videha (i.e., Sītā), while being carried away, did not see any protector, but found five distinguished monkeys staying on the summit of a mountain. In the midst of them the large-eyed beautiful lady released her upper garment made of silk and shining like gold, and beautiful ornaments also, hoping that they would inform

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14 Sircar 1965, 173, remarks: 'The fact that all the stanzas specifically attributed to the *Mahābhārata* cannot be traced in the present texts of the work may be due to the confusion of the scribes or to the loss of the version that contained the verses. The second alternative is not impossible since some verses assigned to the *Mahābhārata* by Hemādri in the thirteenth century cannot be traced in the available versions.' Cf. also p. 171, fn. 4 of the same work.

15 Bhāskara, *Līlāvatī* 70 = *Bījagaṇita* 118.

Rāma ⟨of her situation⟩. ⟨Thus, her⟩ garment and ornaments were thrown and dropped ⟨from the sky⟩ into the midst of them by the beautiful young lady. The one having ten necks (i.e., Rāvaṇa), who was in a hurry, did not notice her action, ⟨but⟩ at that time the best monkeys having red eyes saw the large-eyed Sītā crying out with their eyes as if without twinkling.

The height, 30 *yojanas*, from which Sītā is said to have thrown her garment in the example of the BM, may have been determined in accordance with the legend that Laṅkā, the capital and residence of Rāvaṇa, is 30 *yojanas* high above the earth.[16]

13.2.3 Purāṇas

Purāṇic cosmology and cosmography have influenced some of the examples of the BM. The height of Mount Meru, 84,000 *yojanas*, given in Ex. 15 for Sūtra C10 is very popular in Purāṇic literature.[17]

The height, $1,465 \times 10^5$ *yojanas*, apparently given as that of Brahmaloka ('Brahman's World') in Ex. 19 for Sūtra C10 is, according to the Vāyupurāṇa, the height of the cosmic shell (*aṇḍa/aṇḍa-karpara*) that forms the top ceiling of the Brahmaloka. The relevant passages of the *Vāyupurāṇa* read thus:

mahītalāt sahasrāṇāṃ śatād ūrdhvaṃ divākaraḥ,
divākarāt sahasreṇa tāvad ūrdhvaṃ niśākaraḥ /129/
pūrṇaṃ śatasahasraṃ tu yojanānāṃ niśākarāt,
nakṣatramaṇḍalaṃ kṛtsnam upariṣṭāt prakāśate /130/
śataṃ sahasraṃ saṃkhyāto merur[18] *dviguṇitaṃ punaḥ,*
grahāntaram athaikaikam ūrdhvaṃ nakṣatramaṇḍalāt /131/
tārāgrahāṇāṃ sarveṣām adhastāc carate budhaḥ,
tasyordhvaṃ carate śukras tasmād ūrdhvaṃ ca lohitaḥ /132/
tato bṛhaspatiś cordhvaṃ tasmād ūrdhvaṃ śanaiścaraḥ,
ūrdhvaṃ śatasahasraṃ tu yojanānāṃ śanaiścarāt /133/
saptarṣimaṇḍalaṃ kṛtsnam upariṣṭāt prakāśate,
ṛṣibhis[19] *tu sahasrāṇāṃ śatād ūrdhvaṃ vibhāvyate /134/*
yo 'so[20] *tāramaye divye vimāne hrasvarūpake,*
uttānapādaputro 'sau meḍhībhūto dhruvo divi /135/
trailokyasyaiṣa utsedho vyākhyāto yojanair mayā,
manvantareṣu devānām ijyā yatraiva laukikī /136/
varṇāśramebhya ijyā tu loke 'smin yā pravartate,
sarvāsāṃ devayonīnāṃ sthitihetuḥ sa vai smṛtaḥ /137/
trailokyam etad vyākhyātam ata ūrdhvaṃ nibodhata,
dhruvād ūrdhvaṃ maharloko yasmiṃs te kalpavāsinaḥ,
ekayojanakoṭī sā ity evaṃ niścayaṃ gatam /138/
dve koṭyau tu maharlokād yasmiṃs te kalpavāsinaḥ,
yatra te brahmaṇaḥ putrā dakṣādyāḥ sādhakāḥ smṛtāḥ /139/

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16 Al-Bīrūnī, *India*, trans., Part 1, 307.
17 Kirfel 1920, 93, 184, and 187; and Kirfel 1954, 97.
18 Read *muhur*.
19 Read *ṛṣibhyas*.
20 Read *yo 'sau*.

caturguṇottarād ūrdhvaṃ janalokāt tapaḥ smṛtam,
vairājā yatra te devā bhūtadāhavivarjitāḥ /140/
ṣaḍguṇaṃ tu tapolokāt satyalokāntaraṃ smṛtam,
apunarmārakāmānāṃ brahmalokaḥ sa ucyate /141/
yasmān na cyavate bhūyo brahmāṇaṃ sa upāsate,
ekakoṭir yojanānāṃ pañcāśan niyutāni tu /142/
ūrdhvabhāgas tato 'ṇḍasya brahmalokāt paraḥ smṛtaḥ,
caturaś caiva[21] *koṭyas tu niyutā pañcaṣaṣṭi ca /143/*[22]

One hundred thousand ⟨*yojanas*⟩ high above the surface of the earth is the sun, so many thousand ⟨*yojanas*⟩ high above the sun is the moon, and one hundred thousand *yojanas*, in its entirety, high above the moon shines the whole ring of the lunar mansions (*nakṣatras*). Each of the ⟨five⟩ different planets is one hundred thousand ⟨*yojanas*⟩, multiplied further by two, high above the preceding one, starting from the ring of the lunar mansions. Of all the ⟨five⟩ star planets, Mercury rotates in the lowest ⟨orbit⟩, Venus rotates above it, Mars rotates above it, Jupiter rotates above it, and above it Saturn. One hundred thousand *yojanas* high above Saturn shines the whole ring of the Seven Seers (Ursa Major). The one who is observed one hundred thousand ⟨*yojanas*⟩ high above the Seven Seers, in a small divine vehicle made of stars, is Dhruva (the Fixed One, i.e., Polar Star), the son of Uttānapāda and the central pole of the heaven. The altitude of the three Worlds (i.e., Bhūr, Bhuvar, and Svar) has just been told by me in terms of *yojanas*. There the sacrifice for gods are ⟨performed⟩ by people in the Periods of Manu. The sacrifice, which exists according to the class and stage of life, is traditionally said to be the cause of continuous existence of all the super-human beings. The three Worlds have just been told. Know ⟨the upper Worlds⟩ above it. Above Dhruva (Polar Star) is Maharloka, where ⟨live⟩ the dwellers of Kalpa (eon). That it is one *koṭi* (10^7) *yojanas* ⟨high above Dhruva⟩ has been settled definitively. Two *koṭi* ⟨*yojanas* high⟩ above Maharloka ⟨is Janaloka⟩, where ⟨live⟩ the dwellers of Kalpa, and where ⟨live⟩, it is heard, Brahmā's sons beginning with Dakṣa, the skilful men. Four times ⟨one *koṭi yojanas*⟩ high above Janaloka is said to be Tapas⟨-loka⟩, where ⟨live⟩ the gods belonging to Virāj, who are free from burning creatures. Six times ⟨one *koṭi yojanas* high⟩ above Tapoloka is said to be another ⟨World called⟩ Satya. It is ⟨also⟩ called Brahmaloka, ⟨which is the World⟩ for those who want not to die again, since ⟨there⟩ they serve for Brahmā without falling down again. One *koṭi* and fifty *niyuta* (10^5) *yojanas* high above Brahmaloka is said to be the upper part of the egg (i.e., the cosmic shell). ⟨Its height from the surface of the earth is⟩ fourteen *koṭi* and sixty-five *niyuta* ⟨*yojanas*⟩.

trayodaśaiva koṭyas tu niyutā daśa pañca ca,
bhūrlokād brahmaloko vai yojanaiḥ saṃprakīrtyate /220/
ekayojanakoṭī tu pañcāśan niyutāni ca,
ūrdhvaṃ bhāgavatāṇḍaṃ tu brahmalokāt paraṃ smṛtam /221/[23]

Brahmaloka is said to be thirteen *koṭi* and fifteen *niyuta yojanas* distant from the Bhūr-

21 Read *caturdaśaiva*. The emendation suggested by the editor, '*catasraś caiva*,' does not fit in the context.
22 *Vāyupurāṇa* 101.129–143.
23 *Vāyupurāṇa* 101.220–221.

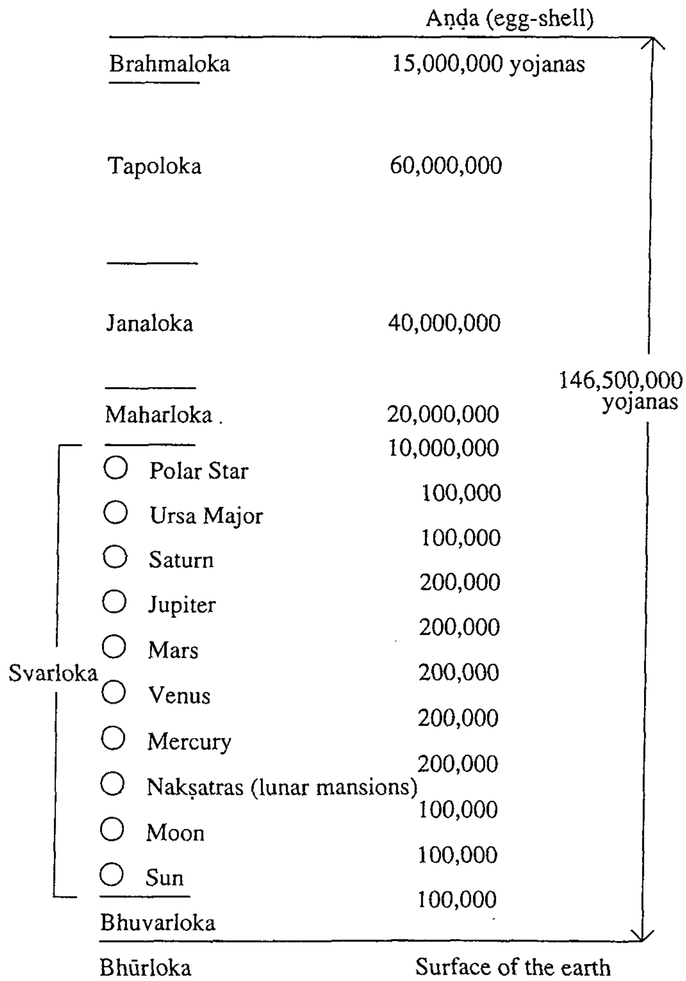


Figure 13.1: Traditioal Seven Worlds (*lokas*) according to the *Vāyupurāṇa*

> loka. One *koṭi* and fifty *niyuta yojanas* high above Brahmaloka is said to be the egg of the Divine Being.

Figure 13.1 shows the sectional elevation of the seven 'Worlds' (*lokas*) according to the cited passages of the *Vāyupurāṇa*.

Exs. 29 and 30 for Sūtra C10 give the sun's daily motion, 5×10^8 *yojanas*, a value which is yet to be attested in Purāṇic literature. Most Purāṇas, however, give 10^4 (or 9×10^3) *yojanas* as the diameter of the sun's orbit (or the sun itself?).[24] In Indian astronomy, the size of the sun's orbit is given on the basis of a kinematic model different from that of Purāṇic cosmology. According to the *Paitāmahasiddhānta* (early 5th century A.D.), for example, its circumference is 4,331,497.5 *yojanas*.[25]

24 Kirfel 1954, 36, 48, and 197.
25 Pingree 1978, 556 and Table V.3.

13.2.4 The Lokaprakāśa of Kṣemendra (ca. A.D. 1050)

Striking similarities both in ideas and in style are found between Ex. 12 for Sūtra C10 and a stanza of the *Lokaprakāśa* ascribed to the Kashmirian Kṣemendra (middle of the 11th century). The former reads:

A: *dīnārako nāma viśā⟨ra⟩(pa)trī*
duqkhārjanīyaṃ sukhabhojanaṃ ca,
tasyārdham ardhaṃ ca yad ardham ardhaṃ
ter(dha)⟨ṃ tadardhe⟩na guruprasādaṃ. (Indravajrā)

The *dīnāra* coin has indeed large wings. It is hard to earn and easy to spend. With one half of half of half of half of half of half of half of it, a favour of one *guru* (spiritual teacher) ⟨is obtained. How much is required for obtaining favours of 108 *gurus*?⟩

The stanza in question of the *Lokaprakāśa*, on the other hand, occurs in the following passage.

sapāpā sapāpaṃ dve □□□sādalagnabhayaḥ (sic),
yasyaitāni na vidyante sa gurur bhavamocakaḥ / 3 / (Śloka)
B: *dīnāram eko 'sti mamenduvaktre*
kuthāpaṭaprāntasubaddhabaddham,
upārjito 'yaṃ bahuhbiḥ prayatnais
tad evam ardhena kuru prasādam / 4 / (Upajāti)
yasya devasya yo dharmaḥ pravṛttiḥ sārvalaukikī,
śrutismṛtiviruddho 'pi devadṛṣṭiḥ sa ucyate / 4 (sic) / (Śloka)
dharma eva hato hanti dharmo rakṣati rakṣitaḥ,
tasmād dharmo na hantavyo mā no dharmo hato vadhīt / 5 / (Śloka)
vipro dharmadrumasyādau skandhaḥ śākhā mahīpatiḥ,
sacivāḥ patrapuṣpāṇi phalaṃ nyāyasya pālanam / 6 /[26] (Śloka)

· · · One who does not have these ⟨characteristics⟩ is the spiritual teacher (*guru*) who releases from worldly existence. / 3 /

B: I have one *dīnāra* coin with me. It is fastened firmly to the edge of a carpet. It has been acquired ⟨by me⟩ with great difficulties. O lady of a moon-like face! Please do ⟨me⟩ a favour with half of it. / 4 /

When the Law (*dharma*) of a certain king is the source (or standard) of conduct known to all people, it is called the View of God even if it contradicts *śruti* and *smṛti*. / 4 /

The Law, when hurt, hurts ⟨people⟩, and when protected, protects ⟨people⟩. The Law, therefore, should not be hurt, lest it, being hurt, should hurt us. / 5 /

The main stem of the Tree of Law is the *brāhmaṇa*, its branch the king, its leaves and flowers the ministers, and its fruit is the protection of justice. / 6 /

Both stanzas, A and B, are based on the ideas that it is hard to earn one *dīnāra*, and that even with a portin of it one would obtain a favour (*prasāda*) of a *guru* in stanza A, and of a lady in stanza B. Stanza B does not contain the word *guru* (if '*kuru*' is not a corruption of *guru*), but the immediately preceding stanza, though much mutilated, speaks of a qualification of the *guru*. The meters of the two stanzas belong to the same class, i.e., the Triṣṭubh, the only difference being the length of the first syllable of each *pāda* except for the first *pāda*. Moreover, both stanzas show the same linguistic peculiarity, confusion of gender. These points seem to be enough for establishing

26 Ksemendra, *Lokaprakāśa*, pp. 76–77.

a close relationship between the two stanzas. The main difference between the two is that, while B has a touch of real life, A exaggerates the mathematical aspect of the motif.

Unfortunately, however, we have several reasons to doubt Kṣemendra's authorship of stanza B. It has been pointed out that the *Lokaprakāśa*, though attributed to Kṣemendra, in its present form contains interpolations as late as the seventeenth century, and that the genuine authorship of the Kṣemendra seems to be confined to only a limited portion of the present *Lokaprakāśa*.[27] In the present case, the content, meter, and the numbering of the stanza seem to indicate that B is a later addition. This, of course, does not exclude the possibility that the entire passage where B occurs may be an interpolation. In any case, however, it does not follow that stanza B is a genuine composition of a later interpolator. In fact, stanza 5 in the above quotation is nothing but *Manusmṛti* 8.15. Moreover, the five and a half Śloka stanzas that follow stanza 6 are found to be citations from *Yājñavalkyasmṛti* 2.68, 69ab, 70, 71, and 72, and from *Manusmṛti* 8.16.[28] It is, therefore, probable that stanza B was also cited by an interpolator from an unknown source.

Sūtra N2 of the BM, though not understood, deals with *huṇḍikā* or a bill of exchange (modern Huṇḍī). The second chapter (*prakāśa*) of the *Lokaprakāśa* contains a number of forms of the *huṇḍikā* as well as of the *cīrikā* (public announcement written on a strip of cloth or paper).[29]

13.2.5 Smṛtis and Nītiśāstras

In Ex. 1 for Sūtra 58, a sales tax on clothes (*vastra*) is given as 1/20 of the value of the commodity. This rate is prescribed by Kauṭilya:

> *vastracatuṣpadadvipadasūtrakārpāsa* ··· *carmamṛdbhāṇḍānāṃ dhānya-* ··· *pakvānnānāṃ ca viṃśatibhāgaḥ pañcaviṃśatibhāgo vā.*[30]
>
> For garments, quadrupeds, bipeds, yarn, cotton, ···, lethers, and earthen wares, and for grain, ···, and cooked foods, one twentieth part, or ⟨otherwise⟩ one twenty-fifth part ⟨of the price is the sales tax⟩.

Law books too advise kings to impose a tax on commodities at the rate of 1/20.

> *śulkasthāneṣu kuśalāḥ sarvapaṇyavicakṣaṇāḥ,*
> *kuryur arghaṃ yathāpaṇyaṃ tato viṃśaṃ nṛpo haret.*[31]
>
> Those, who are proficient in toll-stations and well-versed in all kinds of commodities, should determine the price according to the commodity, and the king should collect one twentieth part from it ⟨as a sales tax⟩.
>
> *arghaprakṣepaṇād viṃśaṃ bhāgaṃ śulkaṃ nṛpo haret.*[32]
>
> Having settled the prices ⟨of commodities⟩, the king should collect one twentieth part as a sales tax.

A customs tax, the rate of which is 1/4 of the quantity, is levied on *kuṅkuma* (saffron) in Ex. 6 for Sūtra 25. Exactly the same rate of tax has not as yet been found in law books. The normal rate

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27 Weber 1898, 292.
28 I owe these identifications to the late Professor Yutaka Ojihara.
29 Cf. Weber 1898, 333–346.
30 Kauṭilya, *Arthaśāstra* 2.22.7.
31 *Manusmṛti* 8.398.
32 *Yājñavalkyasmṛti* 2.261ab.

for imported commodities is said to have been 1/5.[33] We, however, cannot always expect that a rate of tax used in examples of a mathematical text is based on a particular law book; it may have been current one in the time of the author, or it may be simply a fiction.

13.3 Mathematical Works

In this section, the BM is compared with Āryabhaṭa's *Āryabhaṭīya* (AB), Bhāskara's *bhāṣya* on the AB (BAB), Brahmagupta's *Brāhmasphuṭasiddhānta* (BSS), Śrīdhara's *Pāṭīgaṇita* (PG) and *Triśatikā* (Tr), the old anonymous commentary (*ṭīkā*) on the PG (PGT), Mahāvīra's *Gaṇitasārasaṃgraha* (GSS), the younger Āryabhaṭa's *Mahāsiddhānta* (MS), Śrīpati's *Siddhāntaśekhara* (SS) and *Gaṇitatilaka* (GT), the younger Bhāskara's *Līlāvatī* (L) and *Bījagaṇita* (BG), and the Patan Manuscript (PM).[34]

13.3.1 The Āryabhaṭīya (A.D. 499) of Āryabhaṭa (b. A.D. 476)

Seven rules of the BM, or their equivalents, occur in the second chapter called *gaṇita* (mathematics) of the AB. See Table 13.1 at the end of this section. Both works are conspicuous for the absence of the word *pada* meaning the square root. See Sec. 6.4 above.

13.3.2 The Brāhmasphuṭasiddhānta (A.D. 628) of Brahmagupta (b. A.D. 598)

Eight rules of the BM, or their equivalents, are found also in the BSS. See Table 13.1. In both works, the reduction of fractions of the type:

$$a\left(1-\frac{b}{c}\right)=\frac{ac-ab}{c}$$

is called *pañcamajāti* or 'the fifth class,' while in most mathematical texts it is called *bhāgāpavāhajāti* or 'the partial-subtraction class.' See under Sūtras 25 and 26 in Commentary. Both works solve the indeterminate system of equations:

$$\begin{cases} x+a=u^2 \\ x-b=v^2 \end{cases}$$

The only other work that treats the same problem is the GSS. See under Sūtra 50 in Commentary.

13.3.3 The Āryabhaṭīyabhāṣya (A.D. 629) of Bhāskara

Ex. 9 for Sūtra C10, which is concerned with the motion of a snake, is similar to Bhāskara's fourth example for AB 2.26.

Both Bhāskara and our text attach much importance to the verification of answers. The former calls it *pratyayakaraṇa*, and the latter simply *pratyaya*; the latter word occurs also in the Tr and PGT.

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33 Agrawal 1982, 49.
34 For the Patan Manuscript, see Appendix G.

The word *yāva* used in the sense of the square power in the BM occurs also in the BAB in the form *yāvakaraṇa*. These words have not been found in any other works.

The apparently contradictory meanings of the word *karaṇī*, 'the square number' and 'the square root,' occur also in the BM and in the BAB. Moreover, both works employ the plural form of the word for a single '*karaṇī*,' when it is greater than two. For example,

(A) *karaṇyaḥ* 36
3
4 — BAB on AB 2.6 (p. 56)

(B) *śliṣṭhakaraṇyaḥ* 21
40
42 — BM VII 1

What is implied by each expression is, however, not the same. Expression (A) indicates that the number $36\frac{3}{4}$ is here considered to be a *karaṇī*, i.e., a number whose square root is to be obtained, while (B) indicates that $21\frac{40}{42}$ is an approximate square root of 481. We also find in the BAB the phrase, '*karaṇīnāṃ ṣaṣṭiśatatrayam*,' which literally means 'three hundred and sixty *karaṇīs*,' but which actually signifies 'a *karaṇī* whose magnitude is 360.'[35] Such a usage of the plural form of the word *karaṇī* has not been found in later works.

Another, probably more significant, similarity between the two works is the style of exposition. The most complete pattern in each work is as follows:[36]

BAB	BM
Rule (*sūtra*) of AB	Rule (*sūtra*)
Elucidation of the rule	—
Example (*uddeśaka*)	Example (*udāharaṇa*)
Statement (*nyāsa*)	Statement (*nyāsa/sthāpana*)
Computation (*karaṇa*)	Computation (*karaṇa*)
Verification (*pratyayakaraṇa*)	Verification (*pratyaya/pratyānayana*)

The word *sthāpanā* is also used in the BAB, but there it almost always denotes 'statement' of an intermediate result to be employed in the rest of the 'computation.'

13.3.4 The Pāṭīgaṇita and Triśatikā of Śrīdhara (8th century)

Sixteen rules of the BM, or their equivalents, are found also in the PG, which is extant up to the middle of the chapter called *kṣetravyavahāra* (practical mathematics on plane figures). Ten of those occur also in the Tr.

The BM gives three formulas for the computation of gold (*suvarṇagaṇita*), all from the view point, not of the purity, but of the impurity of gold. Some of Śrīdhara's examples (PG Exs. 65 and 66) are given in terms of impurity, and the concept of the impurity is also used in his prescription for making test sticks of different purities (PG 56 and Ex. 67–68), although his computational rules are all given in terms of purity.

Both texts rarely use the *bhūtasaṃkhyā* system or the so-called word-numerals. The earliest datable use of *bhūtasaṃkhyās* with the decimal place-value notation are found in Sphujidhvaja's

35 Bhāskara, *bhāṣya* on *Āryabhaṭīya* 2.10 (p. 75).
36 Cf. Chap. 7 above.

Yavanajātaka (A.D. 269/270).[37] Since then, we find a number of instances in most mathematical and astronomical works except in those which employ alphabetical systems for expressing numbers (e.g., AB and MS). It is, therfore, remarkable that the extant BM contains the only two *bhūtasaṃkhyās*: *bhūta* (= 5) and *rasa* (= 6). These occur only once each (X 1 and VIII 4), and have nothing to do with the decimal notation.[38] The development of the *bhūtasaṃkhyā* system was mainly motivated by the necessity of expressing large numbers metrically. But our text, even when it versifies a number of 27 decimal places (Ex. 1 for Sūtra C8), prefers the ordinary numerals at the cost of correct word-forms.

Still more remarkable is the fact that, out of the entire 251 stanzas of the extant PG (118 for rules and 133 for examples), only two, Ex. 70 and Ex. 115, contains *bhūtasaṃkhyās*, although trivial cases like *śūnya* (= 0), *kha* (= 0), and *rūpa* (= 1), occur sporadically in the rest of the work.[39] It is probably significant that Ex. 70 is composed in Vasantatilakā, an unusual meter in that work.[40] Moreover, at the end of the commentary on Ex. 70, the scribe remarks:

> *eṣa ca dvitīyodāharaṇaślokaṣ ṭīkākṛtā svaṭīkāyāṃ na vyākhyātaḥ.*[41]
>
> This Śloka stanza of the second example ⟨for PG 58⟩ has not been explained by the commentator in his commentary (*ṭīkā*).

This indicates that the entire commentary on Ex. 70 is an interpolation by the scribe. I suspect that Ex. 70 itself might not have existed in the version used by the commentator (*ṭīkākṛt*); it may also have been supplied by the scribe according to other versions. In fact, the scribe is known to have possessed at least two versions of the PG: a *mūlagrantha* (book of the original text) and a *vṛttigrantha* (book of commentary).[42]

As for Ex. 115, however, we do not have good reasons to doubt its genuineness. All that we can say is that Ex. 115 is not indispensable for the PG, since it is one of the three examples given for one and the same rule (PG 99–101).

Śrīdhara's preference for the ordinary numerals rather than the *bhūtasaṃkhyā* is confirmed by another work of his, the *Triśatikā*, which, at least in its published form, does not contain *bhūtasaṃkhyās* except, as in the case of the PG, for several trivial cases.

Śrīdhara's preference for *mūla* rather than *pada* meaning the square root is also worth noticing. The word *pada* in that sense never occurs in the extant BM.[43]

Śrīdhara was a Śaivit Hindu.[44] The author of (at least part of) the BM also seems to have had a special affinity for Śiva. Ex. 26 for Sūtra C10 is concerned with donation of gold to Śūlin (i.e., Śiva); Ex. 1 for Sūtra C9 contains the names of Śūlin (abbreviated Śū) and Bhavānī (abbreviated Bha, consort of Śiva). Moreover, the author seems to hold that mathematics (*gaṇita*) was created by Śiva.[45]

---

37 *Yavanajātaka* 79.62 expresses the date of its composition as '*nārāyaṇāṅkendumitābda*' ('the year measured by the god Nārāyaṇa (1), numerical figures (9), and the moon (1),' i.e., the year 191).

38 See Sec. 9.1.

39 In Ex. 70: *śara* (= 5), *aga* (= 7), *paṅkti* (= 10), *divākara* (= 12), and *bhāskara* (= 12). In Ex. 115: *dasra* (= 2), *yama* (= 2), and *veda* (= 4).

40 Besides Āryā, the following meters are used in the PG: Upagīti (Exs. 11, 17, 92, 94, 103, and 131), Śloka (Exs. 34, 35, 45, 46, 48, 49, 57, 58, 67, 68, 71, 73, 74, 75, 78, 79, 80, 81, 82, 83, 84, 85, 89, 90, 104, 105, 119, 120, and 121), Upajāti (Ex. 16), Vasantatilakā (Ex. 70), and Śārdūlavikrīḍita (Ex. 32).

41 *Pāṭīgaṇita*, p. 73. Cf. Shukla 1959, xxxiv.

42 *Pāṭīgaṇita*, p. 123. Cf. Shukla 1959, xxxiv.

43 See Sec. 6.4 above.

44 Shukla 1959, xxxv.

45 The relevant passage (X 27), however, may also be interpreted as referring to Brahmā, the God of Creation.

13.3.5 The Pāṭīgaṇitaṭīkā (date and author unknown)

As has been pointed out by Shukla, the negative sigh, +, is used both in the BM and in the PGT, and one and the same verse (Sūtra Q10 of the BM), which gives rules for addtion and subtraction of negative numbers, is cited in both works.[46] To this list of similarities may be added the following: the use of the time measure *caṣaka*, and the term *caturthajāti* (the fourth class) used to denote the reduction of fractions of the type,[47]

$$a + \frac{b}{c} = \frac{ac + b}{c}.$$

It may also be noted that both works are preserved in Śāradā script: the BM in its older form, and the PGT in its modern form; and that their unique manuscripts were both discovered in the northern-most part of India.

13.3.6 The Gaṇitasārasaṃgraha (ca. A.D. 850) of Mahāvīra

Twenty-one rules of the BM, or their equivalents, occur also in the GSS. See Table 13.1. Five of those, i.e., Sūtras 16, 22, 23, 54, and C6, do not occur in other texts under consideration.[48] The problem of 'begging' contemplated in Sūtra 10 of the BM is solved for the general case in the GSS. A certain type of linear equations treated in Sūtra N6 is peculiar to the two works. An example of proportionate distribution in Ex. 1 for Sūtra N13 very much resembles an example given under the rules for purchase in proportion in the GSS. The *iṣṭakarman* or the so-called *regula falsi* (Sūtras N8 to N12) does not occur except in the BM, GSS, and L. It is prescribed for specific problems in the BM and GSS, while in the L it is given in general terms. We should also note that the table of weight measures used in the BM very much resembles that for base metal given in the GSS.[49]

13.3.7 The Mahāsiddhānta of Āryabhaṭa (10th or 11th century)

Thirteen rules of the BM, or their equivalents, are found also in the MS. See Table 13.1. None of those rules is, however, peculiar to the two works. It may be mentioned that both the BM and the MS, as well as the GT, use the unusual conversion ratio of the linear measures *aṅgula* to *yava*, 6 : 1.[50]

The date of this work is controversial. R. Billard dates the work A.D. 1510 to 1514 on the basis of statistic treatment of the astronomical parameters given in the work.[51] But there is a literal evidence to show that this Āryabhaṭa florished before the younger Bhāskara (b. A.D. 1113/14).[52]

46 Shukla 1959, xxix and xxxiii.
47 *Pāṭīgaṇita*, p. 58. Cf. Sec. 13.3.2 above.
48 The PM is excluded for the time being, as it belongs to a much later time.
49 See Sec. 12.6, Remark 6.
50 See Sec. 12.3, Remark 1.
51 Billard 1971, 161.
52 Pingree 1992.

13.3.8 The Siddhāntaśekhara and Gaṇitatilaka of Śrīpati (A.D. 1039/56)

Eight rules of the BM, or their equivalents, occur also in the SS, and six rules in the GT. But none of those is of peculiar interest.

13.3.9 The Līlāvatī and Bījagaṇita (A.D. 1149/50) of Bhāskara (b. A.D. 1113/14)

Fourteen rules of the BM, or their equivalents, occur also in the L, but none of those is peculiar to the two works. The problem of a traveling merchant (Ex. 1 for Sūtra C1) occurs in the BG in a slightly modified form, and is solved by means of equations. The problem is not found in the other works under consideration, although it does occur in a later work.[53] The problem of 'begging' (Sūtra 10), the general case of which is solved by Mahāvīra, is treated in the BG with the help of equations.

13.3.10 The Patan Manuscript (later than A.D. 1315)

This incomplete manuscript, HJJM 8894 (see Appendix G), is taken into account here because it contains an example (A23) whose data are astonishingly similar to those of Ex. 9 for Sūtra C10 of the BM. See Commentary. It also contains six rules that are the same as, or equivalent to, those of the BM, though none of them is peculiar to the two works.

13.3.11 Summary

In the foregoing sections, I mentioned a number of similarities found between the BM and other mathematical works, but none of them seems to be sufficient for establishing a direct relation between the BM and a particular work. Certainly the BM has many rules and problems in common especially with the PG and GSS, and some of them do not occur in later works. But this is rather natural as the PG and GSS are collections of rules and examples compiled with a vast scope. It only confirms that most of the rules and examples of the BM existed in the time of Śrīdhara and Mahāvīra, i.e., in the eighth to the ninth centuries.

One thing, however, is certain: the anonymous commentary of the PG and the BM have at least one common source, from which the rule for addition and subtraction of negative numbers has been cited in both works.

Table 13.1 shows the existence of similar rules and problems in tabular form. Further references and mathematical details are given under the relevant *sūtras* in Commentary. For a concordance of rules and examples, see Appendix B.

53 Gaṇeśa, *Gaṇitamañjarī* 148–150 (fol. 26).

Table 13.1: Same or Equivalent Rules and Similar Problems

BM[54]	AB[55]	BSS	PG	Tr	GSS	MS	SS	GT	L	BG	PM
10					B					B	
11											A
–											
13					A				A		A
14											
15	A		A		A						A
16					A						
17=16											
18=17											
19											
20			A		A						A
21=20											
22					A						
23=21											
24			A		A						
25		B	B	B	B	B	B	B	B		
26											
27			A	A	A	A			A		
28			A		A	A			A		
29			A	A		A			A		
–											
50		B			B						
51	A	B					B			B	
52											
53											
54					A						
55											
56											
57											
58											
N1		A	A	A	A	A	A		A		A
N2											
N3			A	A	A	A	A		A		
N4											B
N5=15											
											to be continued

54 The symbol, =, indicates that the two rules are mathematically equivalent to each other.

55 'A' indicates that the same rule, or its equivalent, occurs, and 'B' indicates either that a similar problem occurs, or that the same problem is treated in a different way.

Same or Equivalent Rules and Similar Problems (*continued*)

BM	AB	BSS	PG	Tr	GSS	MS	SS	GT	L	BG	PM
N6					A						
N7											
N8–12					A				A		
N13											
N14											
N15											
N16		B			B		B			B	
N17											
N18	A	A	A	A	A	A	A		A		
N19											
C1	A	A	A	A	A	A	A	A	A		
C2=53											
C3	A										
C4											
C5					B?						
C6					A						
C7			B		B					B	B
C8											
C9=52											
C10	A	A	A	A	A	A	A	A			
Q1		A	A	A	A	A		A	A		
Q2											
Q3		A	A	A	A	A	A	A	A		
Q4		A	A	A	A	A	A	A	A		
Q5											
Q6			A	A		A		A			
Q7=Q3											
Q8											
Q9											
Q10[56]		A					A			A	
Q11											
Q12	A	A	A	A	A	A	A		A		

56 Exactly the same verse is cited in the PGT.

CHAPTER 14

Date and Place of Composition

14.1 Date

As has been stated above (Chap. 3), a comparison of the Bakhshālī script with those of Śāradā inscriptions would give only a vague idea about the date of the manuscript, that is, some time between the eighth and the twelfth centuries A.D. If we take into account the generally accepted principle that formal documents, including inscriptions, tend to preserve older letter-forms than does the contemporary script, we may be able to push up the lower limit to some extent, but we have no means to estimate what extent.

Neither do we have definitive evidence for the determination of the date of the work contained in our manuscript. As has been mentioned above (Chap. 7), the Bakhshālī work consists of at least two strata, that is,

- the original rules and examples, and
- the commentary.

We have seen (in Chap. 13) that the BM has many rules and problems in common with other mathematical works, especially with Śrīdhara's *Pāṭīgaṇita* (8th century) and Mahāvīra's *Gaṇitasārasaṃgraha* (9th century).

This fact, of course, does not give a *terminus ante quem* of the rules and examples of the BM. In fact, the use of the word *niyuta* in an example may indicate that that example, at least, dates from a period before the time of Śrīdhara (see Sec. 6.3). We know very little indeed about the rules and examples that must have existed before Śrīdhara's time. Bhāskara (A.D. 629) tells us that Maskarī, Pūraṇa, Mudgala, and other '*ācāryas*' (teachers) composed mathematical treatises,[1] but none of them is extant now. We can only have a glimpse of Indian mathematics of those early times through the extant astronomical works of Āryabhaṭa, Bhāskara, and Brahmagupta, only a few chapters of which are devoted to mathematics proper.

At any rate, however, we must admit that it is almost impossible to determine the date of a work on the basis of similarities of mathematical rules and examples. Probably more reliable, if not decisive, criteria are the language, the terminology, and the style of exposition. It is fortunate that the BM exhibits a Sanskrit so much affected by a dialect (or dialects), which will prove to be a useful means for the dating, once it has been identified with precision. But I have to leave that task for competent linguists (see Chap. 4).

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1 Bhāskara, *bhāṣya* on *Āryabhaṭīya* 1.1 (p. 7). Cf. Sec. 6.6 above.

The other two criteria, the terminology and the style of exposition, lead us up to the time of Bhāskara, who wrote his commentary on the *Āryabhaṭīya* in A.D. 629 (see Chaps. 6, 7, and 13). Since, however, the abbreviation *yā* for *yāvattāvat* is used in the solution of an example of the BM, the Bakhshālī commentary does not appear to be much older than Bhāskara, who did not use it in a place where it is naturally expected, in spite of the fact that he did know *yāvattāvat* itself (see Sec. 6.6).

I therefore tentatively assign the Bakhshālī commentary to the seventh century A.D. Nothing seems to me to contradict this conclusion except for one thing, that is, the striking similarity found between the Bakhshālī table of weight measures and that recorded by al-Bīrūnī in the early eleventh century in the Panjab (see Sec. 12.6, Remark 5). This is, however, not so unfavourable to our conclusion as it appears to be, since a similar table is known to have already existed in the ninth century in the Deccan (see Sec. 12.6, Remark 6). It is not impossible that the Deccan table itself was brought from the North, or made in imitation of a table that existed in the North.

14.2 Place

The BM was discovered in the village of Bakhshālī, which is located near Mardan (34;10 N and 72;03 E), about eighty kilometers north-east of Peshawar (Skt. Puruṣapura), which was one of the capitals of Gandhāra. The Śāradā script, in which our manuscript is written, was used in Kashmir and the neighboring districts, including Gandhāra (see Chap. 3). In an example, one day for travelers, i.e., the time of daylight, is taken to be 35 *ghaṭikās*. This indicates that the latitude of the intended locality is not less than 33° N (see Sec. 12.1, Remark 1). This fact also points to the district called Gandhāra by ancient and medieval writers.

In the colophon to Section X of our text occurs a fragment of a word that might be related to the locality of the composition of the Bakhshālī commentary. The word can be read as *-rtikāvati* or *-ntikāvati*. The only plausible restoration I can suggest is *mārtikāvatī*, which may be the same as the country of Mārtikāvata mentioned by Varāhamihira (ca. A.D. 550) among other localities of the North-Western India:

> *takṣaśilamārtikāvatabahugirigāndhārapuṣkalāvatakāḥ,*
> *prasthalamālavakaikeyadaśārṇośīnarāḥ śibayaḥ.*[2]
>
> Takṣaśila, Mārtikāvata, Bahugiri, Gāndhāra, Puṣkalāvataka, Prasthala, Mālava, Kaikeya, Daśārṇa, Uśīnara, and Śibi.

These localities and peoples are given here as those ruled by the planet Venus.[3]

The word *mṛttikāvatī* that occurs in the Purāṇas as the name of a city has been identified with different regions, from the Gujarat to the northern Panjab, by different scholars.[4] Nemicandra (ca. A.D. 975) makes Mattiāvaī (= Mṛttikāvatī) the capital of Dasaṇṇa (= Daśārṇa), which is the usual name of Eastern Mālava.[5] On the other hand, Mṛttikāvatī is often associated with the Śālva (or

2 Varāhamihira, *Bṛhatsaṃhitā* 16.25.
3 The Kashmirian writer Utpala (A.D. 967) comments on the stanza thus: '*takṣaśilā nāgarī* (a town), *mārtikāvato deśaḥ* (a place), *bahugiriḥ, gāndhārā janāḥ* (a people), *puṣkalāvatako deśaḥ* (a place), ...'
4 Cf. Dey 1971, s.v. *mārttikāvata*, and Sircar 1967, 99.
5 Kirfel 1920, 226.

Sālva), who are said to have belonged to 'the valleys of the northern Panjab.'[6] D. C. Sircar is probably right in suggesting the existence of more than one city called Mṛttikāvatī and of more than one people called Mārttikāvata,[7] but the position that the word *mārtikāvata* occupies in the cited stanza seems to me to suggest that Mārtikāvata of Varāhamihira, which is the name of a place according to the commentator Utpala,[8] was situated near Takṣaśilā (Taxila) or Puṣkalāvatī (Charsada, about twenty-seven kilometers north-east of Peshawar), i.e., somewhere in the Gandhāra district.

My conclusions are, therefore, that the Bakhshālī commentary (or at least part of it) was composed in Gandhāra, probably in a city called Mārtikāvatī (or Mīrtikāvatī?), and that some of the examples were also prepared for the reader of the same district.

6 Przyluski 1929, 339, 341, and 347.
7 Sircar 1967, 99.
8 See fn. 3 above.

PART II

Sanskrit Text

Notation

- Apart from footnotes, each page consists of five columns: the folio number in the Bodleian numbering, the leaf-fragment number (F^i, if any), the line number either on the folio-page or on the independent fragment, and the line number on the page of this book.
- # (attached to a folio number): The folio has been restored from several fragments bearing different serial numbers in the Bodleian numbering.
- Un/Up: Under/upper leaf.

In the text:

- *Jihvāmūlīya* and *upadhmānīya* are transliterated respectively 'ẖ' and 'ḫ'; transliteration of the other letters follows the regular method.
- =: Unites constituent parts of a single letter (*akṣara*).
- /: A *daṇḍa* or a period of sentence.
- 0: A dot (•) used for indicating a vacant place (*śūnyasthāna*).
- □: One syllable or numerical figure unrestorable.
- . : Unrestorable part of a syllable.
- . . . : An indefinite number of syllables.
- ⟨A⟩: A is lost.
- (A): A does exist, but is illegible.
- Verses (including ambiguous cases) and 'Statement' (*nyāsa/sthāpanā*) are indented.

In the footnotes:

- A > B: A is a graphic error, and should be read B.
- A?B?: B is an alternative reading of A.

I 1 (70^r)

70^r 1 ⟨. . .⟩ ⌣ ⟨. . .⟩

2 ⟨. . .⟩ e □⟨□□□□□□pa⟩

3 (la) 2 to 0 □rītā 7 □⟨□⟩ (pa)la 2 to 1 □⟨□□□eka⟩

4 ttraṃ pala 6 // // udā //

samā(n)i ⟨trīṇi piṇḍāni tā⟩

5 ṇi peśīkṛtāni ca /

dve ca tisraś=⟨ca⟩ (ta)⟨sraś=ca □□□□□□□□/

ta⟩

6 (tas)=tisra samād⟨ā⟩ya tulitāni trayandaśa /

□□⟨□□□□□□

7 kim⟩ (e)kaikasya śabdavaḥ

1	1	1	d⟨ṛśya 13⟩
2	3	4	⟨1⟩

70^r F[1] 1 ⟨. . .⟩ |___| ⟨. . .⟩

2 ⟨. . .⟩ □□□tola 5(0) ṣaḍbhi to

F[2] 1 ⟨. . .⟩

□	(4)

⟨. . .⟩

2 ⟨. . .⟩

35
2

ete bhāgā 5(1) ⟨. . .⟩

3 ⟨. . .⟩

⟨1⟩17	117
(3)5	70

(bhā)⟨. . .⟩

F[3] 1 |___

F[4] 1

□	□

I 2 (70^v)

70^v 1 ⟨. . .⟩ |___| ⟨. . .⟩

1–4. *Example 1 for Sūtra N1.* 1. Only bottom line of enclosure visible. 4–12. *Example 2 for Sūtra N1.* 11. śabdava > śabdaya. 12. Bottom lines and right side of enclosure lost. 13. Only part of bottom lines of enclosure preserved. 15. Enclosure, except bottom line and lower parts of vertical lines, lost. 16. Left side of enclosure lost. 17. Left side and bottom line of right-hand cell of enclosure lost. 18. Enclosure, except bottom-left corner, lost. 19. Enclosure, except upper parts of vertical lines, lost. 20. *Example 3 for Sūtra N1.* Enclosure, except part of bottom lines, lost.

70v 2 ⟨e⟩kattra pala 8 // // udā //
ardhātr̥⟨tī

3 yap⟩ādāṅśaṃ paṃcaśaṣthi nr̥po dadau /
sevakānāṃ tu dīn⟨ā

4 rān kim=ekaikasya kathyatām⟩

1	1	1	dr̥ṣya 65
2	3	4	1

sadr̥(ś)e ⟨□

5 . . . ⟩ | □ | .r̥ □ | (phala 3)0 | ⟨□

6 . . . ⟩ □6(5) // // □□// (tra) □□ | | .r̥ □

70v F1 1 ⟨. . . ⟩ □.r̥⟨. . .

2 . . . ⟩ (6) | prakṣepayuktyā phalaṃ ⟨. . . ⟩

F2 1 ⟨. . . ⟩ □□⟨□⟩ .r̥ □.r̥ □□⟨. . .

2 . . . ⟩ (sa)ṃguṇya phalarāśiḥ □⟨. . .

3 . . . ⟩ (6) eśa (ṇa)⟨. . . ⟩

F3 1 ⟨. . . .⟩y⟨.⟩dh⟨. . . .

2 . . . ⟩ □□⟨. . . ⟩

F4 1 ⟨. . . ⟩ □□□□□□.i ⟨. . .

2 . . . ⟩ □□□ṃ ⟨. . . ⟩

I 3 (69r)

69r F1 1 (nr̥)pa/ yajanaga ⟨. . . ⟩

F1,2 2 sāmya(tā)ṃ

F2

2	2	2	dr̥ṣyaḥ 214 // a(tra) sadr̥ś⟨e kr̥te adha
5	(6)	7	

cchedaṃ⟩

3 vrīhakaṃ / uparimāṃśaṃ taṃḍulā bhavanti // ⟨ṣaḍguṇāḥ sapta dvā⟩

4 (ca)tvāliṃśa / dūnā caurāśīti / eta taṃḍulā / dvācatvāliṃ ⟨śa⟩ paṃcag⟨uṇaṃ daśādhi

5 kad⟩va⟨yaśata⟩ṃ bhavanti / ete vrīhakā sarvattraḥ sthā

---

1. *Example 3 for Sūtra N1.* 1–9. *Example 4 for Sūtra N1.* 6. Upper part of left side lost. 8. The first cell and upper part of the second cell lost. 11. Enclosure, except bottom-right corner, lost. 19–27. *Example 5 for Sūtra N1.* 19. ⟨. . . ⟩ About 20 *akṣaras* lost. 20. 'tāṃ' of 'sāmyatāṃ' appears in the first cell of the next enclosure.

69ʳ F[2] panaṃ asya ‖ ⟨214⟩ / (2)⟨10⟩ ‖ ⟨bhaktaḥ phalaṃ 210 //

6 pra⟩(tya)ya trairāśikena

F[2,3] ḥ

5 āṃ	2 taṃ	210	pha taṃ 84
1	1	1	1

F[3] 7 ⟨dvit⟩īyasya kṛyate /

6 ā⟨ṃ⟩	⟨2 taṃ⟩	⟨210⟩	⟨pha taṃ 70⟩
1	⟨1⟩	⟨1⟩	⟨1⟩

8 ⟨tṛ⟩(t)īyasya kṛyateḥ

7 (ā)ṃ	2 taṃ	210 (āṃ)	pha⟨la⟩ṃ ⟨ta⟩ṃ ⟨60⟩
⟨1⟩	⟨1⟩	⟨1⟩	⟨1⟩

⟨ekatra 214 //⟩

69ʳ F[4] 1 (. . .)

I 4 (69ᵛ)

69ᵛ F[1] 1 ⟨. . .⟩ ‖ ‖ ⟨□⟩ □□□□

2 ⟨. . .⟩ (e)kattraṃ 105 ⟨//⟩

F[2] 3 // ud⟨ā⟩ka //

⟨t⟩ṛ(ṅ)śa⟨ṃ⟩ śata⟨ṃ⟩ tṛbhir=daty(ai)

tṛguṇātṛguṇena tu /

F[1,2] ki⟨ṃ □□□□□□

4 □⟩

F[2] (ya)di vetsi tad=ucyatāṃ

1	3	9	dṛṣya 130
1		1	1

prakṣepayu⟨ktyā jātaṃ phalaṃ⟩

5 | 10 | 30 | 90 | ekattre 1(3)⟨0 //

6 udā //⟩

(u)vān ‖ taṃ śataṃ tṛbhir=datyai

paravaptrāpavaptṛkai /

⟨□□□□□□

1–8. *Example 5 for Sūtra N1.* 1. Enclosure, except left part, lost. 5. Enclosure, except left corner, lost. 7. Enclosure, except left side, lost. 10–11. *Example 6 for Sūtra N1.* 10. Enclosure, except bottom-right corner, lost. 12–20. *Example 7 for Sūtra N1.* 20. Bottom line for the first two cells of enclosure invisible. 21–24. *Example 8 for Sūtra N1.* 22. The unidentified symbol reaches the next line of writing.

69ʳ F² 7 □□⟩
phalaṃ (m)=i
F²,³ ha tad=ucyatāṃ

4	6	9	dṛ 190
1	1	1	

pra⟨kṣ⟩=
F² e⟨payuktyā phalaṃ⟩
F³ 8 | ⟨40⟩ | 60 | 90 | ekattraṃ ⟨190 //
□6

9 □□□□□□⟩ □□.ai □□⟨□□⟩ .īp. □⟨. . .⟩

69ᵛ F⁴ 1 (pa) □

I 5 (68ʳ)

68ʳ F¹ 1 ⟨. . .⟩ □deśadvānya⟨□□□⟩ □ || □ / □ ⟨. . .

2 . . .⟩ □pātya jātā śeṣa 2(10?) ⟨. . .
3 . . .⟩ □ekattraṃ 324 ⟨. . .
4 . . . vyava⟩hārika □draṃ 2 □□⟨. . .
5 . . .⟩ bhāgīya .e ⟨. . .⟩
F² 1 ⟨. . .⟩ || 168 | / | 4 | □ | ⟨. . .
2 . . .⟩ □ || e⟨va⟩ṃ
F³ 1 ⟨. . .⟩ □bdha t. □ || □□ | □ / □ ⟨. . .⟩
2 (. . .)
F⁴ 1 ⟨. . .⟩ □□t. □⟨. . .⟩
2 (. . .)
F⁵ 1 ⟨. . .⟩ □trā .e ⟨. . .⟩
F⁶ 1 (. . .)
2 (. . .)

1–8. *Example 8 for Sūtra N1.* 4. The first three cells appear on F³, 'dṛ' on F²,³, and '190' on F². 7. The first cell of enclosure lost. 10. Enclosure, except left part, lost. 15. Right part of enclosure lost. 16. Enclosure, except right-most side, lost. 17. Numerical figures in enclosure illegible. 22–23. Two illegible lines of about six *akṣaras* each.

I 6 (68^v)

Blank

I 7 (67^v)

67^v 1 (. . .)

2 ⟨□□□□⟩ dhana □□□□⟨□□⟩ □□(a)tha □□(pra)viśam⟨āne . . .

3 trīṇi dat⟩tā yac=cheṣaṃ ta dviguṇa jātā / nirgacchamāne ca(tvā)⟨ri dattāni . . .

4 □□⟩ □□□.praviśamāne canvāri dattāḥ puna dviguṇa jātā .y.⟨. . .

5 □□⟩ □□□śūnyahastaṃ gataṃ tasya kim=attra mūladhanaṃ syāt (//)

6

⟨1⟩ 2 bhā 2	2 2 bhā 3	3 2 bhā 4	4 2 bhā 5	0
⟨1⟩ 1 1	1 1 1	1 1 1	1 1 1	(1)

7 ⟨□□□⟩ □ś⟨ū⟩ṇ⟨ya⟩ṃ sadṛśa paṃcay⟨u⟩taṃ (a)rdha guṇaṃ cāriy⟨u⟩ktaṃ □□□⟨. . . ⟩

I 8 (67^r)

67^r 1 (. . .)

2 ⟨. . . ⟩ $\frac{\langle 16\rangle}{8}\ \frac{(45)}{8}$ jātā $\frac{61}{8}$ □⟨□□□□□□□⟩

3

⟨61⟩	2	□sadṛśaṃ
⟨8⟩	1	

$\ 8\ \frac{1}{2}\ \frac{1(6)}{8}$ (y)uta⟨ṃ kṛ⟩ta⟨ṃ⟩ $\frac{16}{8}\ \frac{61}{8}$ jātā $\frac{77}{8}$ □⟨□□□□□□□□

4 □□sa⟩dṛśaṃ ekasya $\frac{16}{16}$ yutaṃ $\frac{77}{16}$ jātaṃ $\frac{93}{16}$ eṣa phalaṃ bhavati / pra⟨ṣ⟩ṭa⟨kramena □□□□

1–20. *Example 1 for Sūtra C1.* 10. Left side and bottom lines below '⟨1⟩' of enclosure lost. 14. Left side of the first enclosure lost. 15. The first cell of the first enclosure lost. In the second enclosure: $\frac{1}{2} > \frac{2}{1}$.

67[r] 5 □□⟩ □pratyayaḥ

93	1+2 2+	2+2 3+	3+2 4+	4+ ⟨2 5+⟩	⟨0⟩
16	1 1 1	1 1 1	1 1 1	1 ⟨1 1⟩	⟨1⟩

6 huṇḍikāsamānayanasūtraṃ //
dinabhaktaviśeṣaṃ ca vi⟨□□□□□□□/⟩
7 □guṇa⟨ṃ k⟩ryate caiva kālam=eṣāṃ vinirdiśet
trairāśikavidhānena □⟨□□□□□□
8 □⟩ṃ /
ś⟨u⟩l⟨k⟩ā dattaṃ ca pātavyaṃ
sūkṣme dattaṃ ca tatsamaṃ //
udāharaṇaṃ // dvi.i⟨□□□□□□□
9 □□□□□□□□⟩ṃ ⟨□.⟩e ⟨□□□□□□□□.⟩o □
dhanaṃ ⟨□⟩ □⟨. . .⟩

I 9 (31[r])

31[r] F[1] 1 ⟨□□⟩ □ (□ / 1 □) ⟨. . .⟩
2 □yo ⟨. . . pratya⟩
3 ya trairāśikena

31[r]

2 dine 1	⟨d⟩ra⟨ṃ⟩ 3 1 2	168 dinā 11	⟨phalaṃ draṃ⟩

(⟨294⟩ / ⟨11⟩)

4 ⟨d⟩vi⟨t⟩īyasya kryate / sthāpa⟨naṃ /⟩
5

⟨3⟩ (dine) ⟨1⟩	2 draṃ ⟨1⟩ ⟨2⟩	168 dinā 11	phalaṃ draṃ

(140 / 11) prathamena dattaṃ (dvitī)⟨yasya drammā⟩
6 s saptaḥ dattais=samadhanā jātā // hara(sa)mī □□⟨□
7 □□⟩ □sadṛśaṃ (77 / 11) (294 / 11) pātya śeṣaṃ (217 / 11)
dvitīyasya datyaḥ ⟨yut⟩o ⟨jātaḥ⟩

1–2. *Example 1 for Sūtra C1.* 2. Enclosure after '$\frac{4+}{1}$' of the fifth cell lost. Bottom line for the first cell single. 3–9. *Sūtra N2.* 10–12. *Example 1 for Sūtra N2.* 13–23. *Example 1 for Sūtra C2.* 15. 'k' and 'na' on 31[r]. 17. Enclosure lost. 18. 'vi' and 'īya' on F[1]. 19. '(dine)' and '2' on F[1]. 21. '(sa)mī □□' on F[2]. 23. 'o' on F[2].

31ʳ 8

⟨140⟩	(7)7	217
⟨11⟩	⟨11⟩	11

eśa samadhanā jātā // // punānyaṃ m=ardhabha⟨□□□□⟩

9

⟨prathamasya⟩ / bhā 4 dine / draṃ 15 jīvyā
1
4+

dvitīyasya / bhā 3 dine / draṃ ⟨□□jīvyā⟩
1
2

10 (. . .)

31ʳ F[4] 1 kṣiptadimū

F[5] 1 vakṣayaja □

F[6] 1 □□

I 10 (31ᵛ)

31ᵛ 1 ⟨. . .⟩ □□śa ⟨m⟩u⟨d⟩ ga ⟨. . .

2 . . .⟩ □kāraṇaṃ //

2	1
draṃḥ 4 taṃ	draṃḥ 6 mudgā
1	1
2	2

3 ⟨. . .⟩ □cchedasaṃguṇe / (a)⟨. . .

4 . . .⟩ ūrdhayutaṃ / hṛte phalaṃ // asya guṇākāradvayā /

2	1	⟨. . .
9	13	
2	2	

5 . . .⟩ □adhe uparaṃ guṇaye / ādau tāva dvi⟨. . .

6 . . .⟩ □guṇay⟨e⟩ 2 ⟨□□⟩ □□ anena dvina vabhāgesv=adha □⟨. . .

7 . . .⟩ 9 □4 l(?) ⟨. . .⟩e⟨. . .⟩

31ᵛ Un 1 ⟨. . .⟩ | ⟨□□⟩ □0 | 2 | ⟨. . .

1–2. *Example 1 for Sūtra C2.* 1. '(7)7', '2' of '217' and '11' on F[3]. 2–5. *Example 2 for Sūtra C2.* 3–4. Enclosure up to the first *daṇḍa* and after the last 'draṃ' lost. 9–18. *Example 1 for Sūtra N3.* 14. Bottom left and right corners of enclosure round. 19. Under leaf. Bottom lines of the first cell of enclosure lost.

31^v	Un	2	. . . ⟩ \\□□□/ □t.j.t.j.□ku(?) □□□□□⟨. . .
	Un	3	. . . ⟩ anena guṇita ⟨. . .
	Un	4	. . . ⟩ ādiśet ⟨. . .
	Un	7	. . . ⟩ 12 ‖ 90 □□ ‖ ⟨. . . 1 ‖ 23
	Un	9	. . . ⟩ // ⟨. . . ⟩
31^v	F^1	1	⟨. . . ⟩ □□ṭa$_{\text{na}}$ ka □⟨. . .
		2	. . . ⟩ □yacaraga □⟨. . .
		3	. . . ⟩ // sūtraṃ // □□⟨. . .
		4	. . . .⟩o⟨. . . ⟩
	F^2	1	(. . .)
	F^3	1	⟨. . . ⟩ □□ | □ ⟨. . .
		2	. . . ⟩ rā □□□⟨. . . ⟩
	F^4	1	□ṇāṃ pha.i
	F^5	1	| 4 | 3 □
	F^6	1	□□

I 11 (30^v)

30^v	1	⟨. . . ⟩ dhana⟨ṃ⟩ | □□ ⟨. . . | 1
	2	. . . ⟩ □kā □⟨. . .
	3	. . . ⟩ (ta)smāt=sadṛśaṃ kṛ⟨yate . . .
	4	. . . ⟩ bhāgahāraṃ kṛyate | 234 | ⟨117⟩ | ⟨. . . | 70 | 7⟨0⟩ |
	5	. . . ⟩ ta⟨ṃ⟩ḍulā ḍhe 3 | mudgā ḍhe 1 | ⟨. . . 24 | 47 70 | ⟨70⟩
	6	. . . ⟩ □k⟨ṛ⟩yate / ⟨. . . ⟩
	7	(. . .)

I 12 (30^r)

30^r	1	⟨. . . ⟩ ‖ ⟨. . . ‖ (6)

1–5. Under leaf. 4. Bottom lines of the first cell lost. 14. Bottom line of the second cell lost. 20. Bottom-right corner of enclosure lost. 23. Only bottom-left corner of enclosure preserved.

30ʳ 2 . . . ⟩ sū pra⟨. . .
3 . . . ⟩ sūtraṃ /
ekayutā narasaṃkhy⟨ā . . .
4 . . . ⟩
sarva ṣṣaḍbhi paṇar=gu(ṇaye) anena la⟨b⟩dha ⟨. . .
5 . . . gṛ⟩hītā p⟨ṛ⟩thaṃ

(3)6	42	48	54	6⟨0⟩
⟨dha 6⟩	ṣa ⟨7⟩	dha 8	dha ⟨9⟩	⟨dha 10⟩

I 13 (28ʳ)

28ʳ 1 ⟨. . . ⟩ prānta | 4 □□ || ⟨. . .
2 . . . ⟩ □taṃ dviguṇaṃ dviguṇaṃ bhāraṃ same
□□7 |
⟨. . .
3 . . . ⟩ □la(bdha) 14 // // puna kṛ(tv)⟨ā . . . ⟩
4 (. . .)

28ʳ Un 1 (. . .)
Un 2 ⟨. . . ⟩ 17 □□⟨. . .
Un 3 . . . ⟩ eka □□(dhana) □□258⟨. . . ⟩

28ʳ F[1] 1 □11 śe (2) □
F[2] 1 ⟨. . . ⟩.ṛ.(upa)□□⟨. . .
2 . . . ⟩ □□□□□⟨. . . ⟩
F[3] 1

	(5)
6	1
	(9)

F[4] 1

	(3)	9	
1	3		□
9	(2)4		

I 14 (28ᵛ)

28ᵛ 1 ⟨. . . ⟩ □□(bha)vet // dvāda⟨śa . . .
2 . . . ⟩ □□guṇaye / 1/12 / 1/8 / guṇita jātā 1/9⟨6⟩ ⟨. . .
3 . . . ⟩ (saga)ï āhudvā aḍho (ā)ṣ(ṭa)guṇa □⟨. . .

---

1. sū?ya? 2–4. *Sūtra Q8.* 7. Bottom line and right side of enclosure lost. ṣa > dha?. dha?7? 13–15. Under leaf.

28v 4 . . .)ṇāṃ abhāgasya divardhāḥ=kiṃ 1 1 phalaṃ (. . .
96 1
2

5 . . .) (a)ṣ(ṭ)au abh(āga . . .)

28v F1 1 (. . .)

F2 1 □phalaṃ 5
9 □

F3 1 □.ṛ □□

F4 1 kiṃ (1 / 96) □

I 15 (66r)

66r 1 (□)y(e)t (.)ṛdyuta bhāgah(āra) □□(□□□□) □(□ //
udā //

2 ya)dy=ekāt=paṃtupaṇyānāṃ ekadvitṛcatuṣṣaṭ sa /
(tadā kiyatā)

3 (dra)mmāṇāṃ samapaṇyāni m=ānayaḥ
sthāpanaṃ kṛyate (□□□□)

4

(draṃ) 1 1 1 1	draṃ 1 2 1 1	draṃ 1 3 1 1
draṃ 1 4 1 1	draṃ 1 6 1 1	

(karaṇaṃ /

5 □□) (gu)ṇe tu sadṛśaṃ / (□□□□

6 □) □□(ha) 1 6 / 4 / (3) / 2 / śeṣaṃ □(. . .)
1 1 (1) 1 (1)

66r F1 1 □ṣṭhā □

I 16 (66v)

66v 1 (. . .) (pratya

2 ya t)r(ai)(rā)śikena /

(1) draṃ (1)	1 rū 1	12 draṃ 1	phalaṃ rūpa 12

3

(1) draṃ (1)	2 rūpa 1	6 draṃ 1	phalaṃ rūpa 12

---

7. *Sūtra N4.* 8–22. *Example 1 for Sūtra N4.* 13. Left half of the first cell lost. 14. Right side of enclosure lost. 17. $\frac{1}{1} > \frac{12}{1}$/. 21. Right side of enclosure lost. 22. Left side of enclosure lost.

66ᵛ 4

⟨1⟩ draṃ ⟨1⟩	3 rūpa 1	4 draṃ 1	phalaṃ rūpa 12

5

⟨1 draṃ⟩ ⟨1⟩	4 rūpa ⟨1⟩	3 draṃ ⟨1⟩	(pha)laṃ rūpa 12 gaga

6 ⟨. . . ⟩ □ma □ṃ □□.e(kṣa)

66ᵛ F¹ 1 pa

I 17 (53ʳ)

53ʳ 1 (. . .) ⟨gati

2 sām⟩yatā

1 yo 1 di 1 1 2	6 ⟨dinagatasya gatayojana 9⟩ 1 ⟨1⟩	⟨dvi 2 yo 1 di⟩ ⟨1 1⟩

⟨kara⟩

3 ṇaṃ // ⟨gati⟩

4 syaiva viśeṣaṃ tu / tatra gatiṃ $\begin{array}{|c|c|}3 & 2\\ 2 & 1\end{array}$ viśeṣaṃ $\frac{1}{2}$ vibhaktaṃ $\frac{2}{1}$ ⟨□□□□□⟩

5 p⟨ū⟩rvagata 9 anena guṇaye 18 anena kāl⟨ena sa⟩

6 (ma)gatī bhaviṣyati // pratyaya trairāśikena /

1 di 1	⟨3 yo⟩ ⟨2⟩	⟨18⟩ ⟨1⟩

7 (pha) yo 27 / pūgatadina $\frac{6}{1}$ ato yojana 9 (dvi

8 t)īyaḥ

1 di 1	2 yo 1	1(8) di 1

phalaṃ yojana 36 ⟨. . .

9 . . . ⟩

1	(8)	9 12	6

1–3. *Example 1 for Sūtra N4.* 1. Left side of enclosure lost. 2. The first cell, right side, and bottom line of enclosure lost. 3. The sixth line is written vertically, from the bottom to the top of the page, to the right of the four enclosures. 4. pa?5? 5–18. *Example 1 for Sūtra N5.* 7. Enclosure after '$\frac{2}{1}$' of the third cell lost. 15. Enclosure after '$\frac{3}{2}$' of the second cell lost. 16. pū > pūrva. 17. Right half of bottom lines of the third cell lost. 18. Bottom lines for the third and fourth cells lost.

I 18 (53ᵛ)

53ᵛ 1 (. . .)

2 ⟨□□□□□□□prat⟩ya⟨yas=trairāśikena /⟩ (sthāpana)⟨ṃ k⟩ṛyate /

3

⟨96 dine⟩ ⟨1⟩	18 yojana 1	20 din⟨e⟩ 20 ghaṭike 35 gha dina	phalaṃ yo 2(7) 7
⟨100 d⟩i⟨n⟩e ⟨1⟩	25 yo 1	20 dine 20 ghaṭike 35 ghaṭike dinu	pha yo 36 7
			⟨yutaṃ yo 9⟩ ⟨1⟩

4 ⟨□□□□⟩ □□□□□// kāṃsy⟨ā⟩tma □⟨□□□⟩ □□□

5 (. . .)

1–6. *Example 1 for Sūtra C3.* 4. Both sides of enclosure, bottom lines up to the middle of the first cell of the top row, and those for the first cell of the second row, lost. Of the third row, the upper half of the left side preserved.

II 1 (54^r)

54^r 1 ⟨. . . .⟩ṣa⟨□⟩t. y⟨o⟩gaḫ kartavya(ḥ) ⟨s⟩samakṣīr.r.ṇ.⟨s⟩ya ⟨□⟩

1 1	2 1	4 1	(8) 1

2 ⟨. . . ṛ⟩(ṇa)sya dhanaṃ / dhane ṛṇa yāta / tayor=yoga viyo⟨gaṃ syāt

3 . . . ta⟩(th)ā kṛtā rāśayaḥ

2	1	2+	9+
1	1	1	1
1	2	4	8
1	1	1	1

dṛ 82

4 ⟨. . . utta⟩(r)āṃ bhājya hitveti / tatra uttararāśi⟨. . .

5 . . .⟩ uttaraṃ riṇaṃ jātaṃ / 8(+) ⟨. . .⟩

54^r F1 1 ⟨bhā⟩j⟨ya⟩to hi(tv)⟨ā⟩

F2 1 (. . .)

2 ⟨. . .⟩ ṣeṣāḫ=p⟨uruṣabhājitāḥ⟩

F3 1 □ka(?)

F4 1 ⟨. . . .⟩y⟨. .⟩y⟨. . . .

2 . . . .⟩o⟨. . .⟩

F5 1 ⟨. . .⟩ □□□⟨. . .

2 . . .⟩ □.y. bhya v. □⟨. . .⟩

F6 1 ⟨. . .⟩ / eṣa ⟨. . .

2 . . .⟩tīyasya dhanaṃ ⟨. . .⟩

F7 1 ⟨. . .⟩ □⟨□⟩ □⟨. . .

2 . . .⟩

1 1	164 1

F8 1 śeṣa 19/1 □□

F9 1 ⟨sap⟩tamasūtraṃ

F10 1 ⟨. . .⟩ □□□pu⟨. . .

2 . . .⟩ jātaṃ 76 eṣa prathamasya □□⟨. . .

3 . . . .⟩i⟨□□□⟩ṃ □□⟨. . .⟩

F11 1 ⟨. . .⟩ aśvagṛha ⟨. . .

2 . . .⟩ jā □ṃ ⟨□□.⟩o⟨. . .⟩

1–7. *Example 1 for Sūtra N6.* 2. Enclosure for the first two upper cells visible, but no numerals inside. Right side of enclosure lost. 6. bhājya > bhājyato. 19. Right side of enclosure lost.

II 2 (35^r^)

35^r^ 1 (. . .)

2 ⟨. . .⟩ kasmāt=kāraṇā / tayor=yoga vriyogaṃ syā viyoga sa⟨t⟩i ⟨saṃgamaḥ / . . .

3 . . . śeṣāḥ=pu⟩ruśabhājitā puruśa 15 anena bhaktvā dhanaṃ [9⟨0⟩ / 15] ⟨vartyaṃ jātaṃ 6 // // udā // . . .

4 . . .⟩ □(tu) / tad=rūpadvayasahitaṃ // □⟨□⟩ □□⟨. . .⟩

5 (. . .)

II 3 (35^v^)

35^v^ 1 (. . .)

2 ⟨. . .⟩r⟨.⟩tārdhamūlena [1 / 1 / 2] eta dviguṇaṃ [3] dviyutaṃ ⟨eva⟩ [⟨5⟩] ⟨. . .

3 . . . dvitī⟩yasya dhanaṃ / tad=eva svārdhaṃ [3] asyārdhaṃ [1 / 1 / 2] yutaṃ nyāsa // □⟨. . .

4 . . .⟩ (eta tṛ)tīyas⟨ya dhana⟩ṃ ⟨. . .⟩

35^v^ Up 1 ⟨. . . trairāś⟩ik⟨e⟩na [□ / 1 □] ⟨. . .⟩

Up 2 (. . .)

II 4 (54^v^)

54^v^ 1 ⟨. . .⟩ □□rdha(ka)⟨ṃ⟩
dviguṇaṃ ca trrūnaṃ ca
tṛtīyasya dhanaṃ bhavetāṃ /
⟨□

2 □□□□□⟩ □ś=ca .yā □ś=cai kila saṃyutaṃ /
ekaviṃśatibhiḥ=krīto dīnārais=tu narai □□⟨/

3 □□□□□□⟩ □yā yatudaṃśāṃ pṛthag=vamaḥ //

1–5. *Example 1 for Sūtra N6*. 5–13. *Example 2 for Sūtra N6*. 5. Right half of enclosure lost. 10. Enclosure lost. 14–15. Upper leaf. 14. Bottom line of enclosure lost. 16–22. *Example 3 for Sūtra N6*. 18. bhavetāṃ > bhavet. 22. yatudaṃśāṃ > yat tadaṃśāṃ. vama > vada.

54^v 4 karaṇaṃ // yasya padaṃ na jñāyate (ta) □
⟨□□□□□□⟩ □□□dīnārai // yā 1 // etat=
1
p⟨ra⟩thamasya dhanaṃ / ⟨. . .⟩

54^v F[1] 1 (. . .)
F[2] 1 (. . .)
F[3] 1 (. . .)
F[4] 1 (. . .)
F[5] 1 (. . .)
F[6] 1 tryūṇaṃ □
F[7] 1 ⟨. . .⟩ ‖ 1 / 4 ‖ ⟨. . .
2 . . .⟩ya⟨. . .⟩
F[8] 1 □□□ | □□ / vi 5 | dha
F[9] 1 ⟨. . .⟩t⟨.⟩ ca dattavān hastaga⟨ta . . .
2 . . .⟩ □□paṃ □⟨. . .⟩
F[10] 1 ⟨. . .⟩ | 4 / 1 / 2 | eta ⟨. . .
2 . . .⟩ □□□(sa)rveṣāṃ ‖ 0 ‖ 2 / □ ‖ (2)+ ‖ □⟨. . .
3 . . .⟩ □□□⟨. . .⟩
F[11] 1 (. . .)

II 5 (35#^{r})

51^r F[1] 1 ⟨. . .⟩ pātya śe(ṣa) ⟨□□□□□□□⟩

⟨0⟩	⟨1⟩	⟨1⟩	⟨dṛśya 21 //
⟨1⟩	⟨1⟩	⟨1⟩	
⟨1⟩	3	3	
4	(2)	1	

2 uttarāṃ⟩ bhājyato hitvā / tatrottarā 1 / 1 / yutaṃ (2)
⟨bhājyaṃ⟩ (⟨21⟩) ⟨ataḥ
3 śodhita⟩ṃ | ⟨1⟩9 / ⟨1⟩ | śeṣāḥ=puruṣabhājitā /

1–3. *Example 3 for Sūtra N6.* 19–23. *Example 3 for Sūtra N6.* 20. Enclosure, except bottom-left corner, lost. 22. Enclosure lost. 23. Enclosure, except right side, lost. 'puruṣabhājitā /' extends on 35^{r}F.

35r F puruṣaḥ

1	3	3
4	2	1

eṣā sadṛśe yu⟨tiṃ

4 bhājita⟩ṃ (4)/(19) dhanaṃ 19/1 / anena guṇitaṃ jātam 4 eṣa prathamasya dha⟨na⟩ṃ / ⟨tattrayārdhaṃ⟩

5 dviguṇaṃ 12 dviyutaṃ / 14 eta dvitīya⟨sya dhanaṃ /

6 tryardha⟩guṇaṃ 21 dviguṇaṃ 42 tryūnaṃ 39 eṣaḥ nyāsaḥ pratya(ya)⟨s=trairāśikena

7 ya⟩d⟨i⟩ samagravṛndānāṃ caturdaśa ekonacatvāriṃśa / tat=pādārdhatṛbhāgān⟨ā⟩ṃ ⟨kim=iti⟩

8

⟨1⟩ ⟨1⟩	4 ⟨1⟩	1 4	pha 4 1
⟨1⟩ ⟨1⟩	⟨14⟩ ⟨1⟩	⟨1⟩ ⟨2⟩	⟨pha 7⟩ ⟨1⟩
⟨1⟩ ⟨1⟩	⟨39⟩ ⟨1⟩	⟨1⟩ ⟨3⟩	⟨pha 13⟩ ⟨1⟩

evaṃ dī 21 /

eṣa praṣṇa etair=dī⟨yat⟩e ⟨...⟩

51r F[1]

Up[1] 1 ⟨...⟩ □□ṇa dhaṇa ny⟨ā⟩(sa) (1)/2 ⟨...

2 ...⟩ □□ṇaṃ ⟨.⟩o⟨...⟩

Up[2] 1

⟨□⟩	2
2	1

II 6 (35#v)

51v F[1] 1 ⟨□□□⟩

⟨3 +⟩ ⟨1⟩	⟨4 +⟩ ⟨1⟩	⟨5 +⟩ ⟨1⟩
⟨1⟩ ⟨4⟩	⟨1⟩ 6	⟨1⟩ (5)

⟨dṛśya 99⟩ □□⟨□⟩

□⟨□□⟩taḥ ⟨□□□□□□□□□□

2 □□□⟩ asya sa⟨ṃ⟩yogaṃ 111 śeṣāḥ=puruṣabhāji⟨tāḥ / tatra pu⟩

35v F 3 (ru)ṣaḥ (1)/1/1/ sadṛśe yutiṃ kṛtvā jātā 37/60
4 6 5

1–10. *Example 3 for Sūtra N6.* 6. eṣaḥ nyāsaḥ > eṣa tṛtīyasya dhanaṃ / nyāsaḥ 4 / 14/ 39. 7. caturdaśa > catuś-caturdaśa. 9. Enclosure, except vertical lines for the first row, lost. pha 4 > pha 1. 11–13. Two upper leaves. 13. Left side and bottom line for the first cell lost. 14–18. *Example 4 for Sūtra N6.* 14. Enclosure, except bottom right parts, lost. 18. 'dṛśe ...' (up to the enclosure) extends on 51vF[1].

51^v F[1] bhājitā | 60 ⟨37⟩ | ⟨anena guṇitaṃ

35^v F 4 jātaṃ 18⟩(0) // eṣa gavāśvamahiṣī pratyaikaśāleṣu bhava⟨nt⟩i ⟨/ p⟩(ra)⟨tya

5 yas=trair⟩āśi⟨k⟩e⟨na⟩

1 śā ⟨1⟩	180 gā ⟨1⟩	1 4	phalaṃ 45 ⟨3+⟩ ⟨1⟩	⟨42⟩
1 śā 1	180 aśvā 1	1 6	phalaṃ 30 4+ 1	26 ⟨/ 31 /⟩
1 śālā 1	180 mahi	1 5	phalaṃ 36 5+ 1	

6 ⟨□□⟩ □□.ādhe /

7 ⟨evaṃ sa⟩(rva yuta)ṃ 9(9) ⟨//⟩

51^v F[1]

Un 1 ⟨. . . ⟩ □ // udā dhanaṃ te ⟨. . .

Un 2 . . . ⟩(ṇ)o(n)i(t)āṃ dhanaṃ □□□⟨. . . ⟩

II 7 (51^r)

51^r 1

⟨□□□□□□□⟩	⟨0⟩ ⟨1⟩	⟨1⟩ ⟨1⟩	⟨2⟩ ⟨1⟩	⟨3⟩ ⟨1⟩	⟨dṛ 54⟩ ⟨1⟩
	1 1	1 1	1 1	1 1	

⟨uttarāṃ bhājyato hitvā /

2 u⟩ttarā / 1 / 2 / 3 / eṣāṃ yuta⟨ṃ⟩ | 6 1 | va⟨rjitaṃ jātaḥ

3 śe⟩ṣa | 48 | śeṣāḥ=puruṣa śa 4 // anena bhajitā r=labdham | 1⟨2⟩ | ⟨eṣa pra

4 thama⟩sya bhavati / 12 / 13 / 14 / 15 / ekattraṃ 54 //

5 udā //

kaścid=rājā dade dānaṃ saptapaṃcāśakaṃ budha /
paṃcāśva⟨vāhakānāṃ⟩

6 ca pravakṣyāmy=anupūrvaṣaḥ

1–7. *Example 4 for Sūtra N6.* 1. Bottom part of enclosure lost. 5. '31 /' written in the second row should be placed to the right of the bottom row of enclosure. 8–11. Under leaf. *Example 5 for Sūtra N6.* 12–17. *Example 6 for Sūtra N6.* 12. Enclosure for the top row, except the lower half of left side and bottom lines for the last (fifth) cell, lost. 18–21. *Example 7 for Sūtra N6.*

51^r dviguṇādviguṇaṃ caiva rūparūpottare⟨ṇa ca /
kiṃ ta⟩

7 t⟨ra⟩ prathame prāptaṃ kiṃ prāptaṃ apare jane

0 1	1 1	(3) ⟨1⟩	⟨7⟩ ⟨1⟩	⟨15⟩ ⟨1⟩	⟨dṛ 57⟩ ⟨1⟩
⟨1⟩ ⟨1⟩	⟨2⟩ ⟨1⟩	⟨4⟩ ⟨1⟩	⟨8⟩ ⟨1⟩	⟨16⟩ ⟨1⟩	

51^r F^1

$F^{2,3}$

F^4 1 | (2)9 |
□

F^5 1 +⌣ aya⟨ṃ⟩ riṇa⟨ṃ ...

2 ...⟩ □⟨□□.⟩o □⟨...⟩

F^6 1 ⟨...⟩pt⟨ā⟩(tha ha)⟨...

2 ...⟩s(ya v)iṃ⟨...⟩

II 8 (51^v)

51^v 1

(0) 1	(3) ⟨2⟩	⟨1⟩2 2	39 2	⟨120⟩ 2	⟨dṛ (329) 1
⟨1⟩	⟨3⟩	⟨9⟩	27	81	

karaṇa⟨ṃ⟩ / uttarā⟨ṃ⟩ (bh)ājya hi⟨t⟩(v)⟨ā⟩

2 tatrottararāśīnāṃ yoga 87 /

3 eṣadhanā dṛṣyā śodhanīyā jātā 242

4 ⟨śeṣāḥ=puruṣabhā⟩j⟨i⟩tā / puruṣa // 1 / 9 / 27 / 81 / yoga
121 ane⟨na bhā

5 jitaḥ śeṣaḥ⟩ | ⟨24⟩(2) / ⟨121⟩ | jātā ⌣2⌣ eṣa dvau prathamasya
dhanaṃ // 2 / 6 / 18 / 54 / 162 ⟨/

6 □□□□□□⟩ uttararāśīsaṃyutaṃ jātaṃ /

2 1	15 2	48 2	147 2	444 2

eṣāṃ saṃ(y)⟨utiḥ 329 // □⟩

□□□ṃ (32)9 □□□□□□□□□□□□//

1–4. *Example 7 for Sūtra N6.* 4. Enclosure mostly lost, but vertical lines for the first two cells of the top row preserved. 5. See II 5 for 51^rF^1. 6. See II 9 for $51^rF^{2,3}$. 12–22. *Example 8 for Sūtra N6.* 12. Left half of enclosure lost. Numerals in the first three columns and '39' in the fourth column appear on 51^vF^2. 13. bhājya > bhājyato. 16. 1 / 9 / > 1 / 3 / 9 /. 18. Left half of the first enclosure lost.

51^{v} F^{1}

F^{3} 1 ⟨.⟩ārdha⟨. . . ⟩

F^{4} 1 □ | 2

F^{5} 1 □m=upādīyat⟨e⟩ // □

F^{6} 1 10

II 9 (52^{r})

52^{r} F^{2} 1 ⟨. . . ⟩ | ⟨1⟩9 / ⟨4⟩0 | bhaktvā | 40 / 19 | ⟨. . . ⟩

52^{r} 1 □□⟨□□⟩ / an⟨ena . . .

2 dha⟩nā 57 tsedaṃ jātaṃ 3 anena cāli⟨ṃ⟩śa guṇaye jātā
1
12⟨0 // eṣarāśi⟩

3 (r=a)śvavaṃsurāṇāṃ // pratyaya trairāśikena /

1 vaṃ 1	120 1	1 10 1	1⟨2 aśva⟩ 1	⟨evaṃ 57⟩
1 vaṃ 1	120 1	1 8	15 aśva 1	
1 vaṃ 1	120 1	1 4	30 a⟨śva⟩	

4 (//) // udā //
dhanā svamardho saṃśoddhya
51^{r} F^{3} ta⟨tse
52^{r} 5 ṣā⟩ ca turīyakaṃ /
tatseṣā paṃcamo bhāgo
te ⟨ca pi
6 ṇḍaṃ⟩ śatadvayaṃ /
aśītyādhikaṃ dhanaṃ caiva
kim=ādyaṃ prathamaṃ dhanaṃ //
⟨□□□□□□□□⟩

7 (. . .)

---

1. See II 6 for 51^{v}F^{1}. 6. Left half of the first enclosure, and right half of the second, lost. 7–11. *Example 9 for Sūtra N6.* 11. Right side, and right half of the fourth cell of the bottom row, of enclosure lost. 'aśva' and part of '5' in the fourth cell of the second row appear on 51^{r}F^{3}. Delete the bottom '1' in the third cell of the first row. 12–22. *Example 1 for Sūtra C4.*

II 10 (52^v)

52^v 1 (. . .)

2 ⟨. . .⟩ □□□□□⟨□⟩ □□□(200) // asya dvayānāṃ pāda ⟨50⟩ ⟨. . .

3 . . . di⟩(va)rdhaṃ śataṃ bhavati 150 atrāpi paṃcabhāga 30 // evaṃ □⟨. . .

4 . . .⟩ □//

1	1	1
2	4	5
	1	1
	2+	4+
		1
		2+

pha piṇḍa 280 //

paṃcamījātīkaraṇaṃ kṛ(taṃ) ⟨. . .

5 . . .⟩ .ī pi 280 // aṃśayuti $\frac{28}{40}$ bhaktaṃ $\frac{40}{28}$ dhana 280 ⟨. . .

6 . . .⟩ □□400 eṣa phalaṃ bhavati //

1–10. *Example 1 for Sūtra C4.* 10. The remaining one-and-a-half-line space on 52^v is left blank.

III 1 (1^r)

1^r 1 bhyāsa \20/ □□□□ \⟨. . . ca⟩
2 turguṇaṃ paṃcaguṇaṃ hastagataṃ dhana⟨ṃ⟩ /
⟨p⟩ra⟨t⟩ya⟨ya . . . ⟩
3 paṃcaguṇaṃ 25 //

navamasūtraṃ 9 // //

sūtra⟨ṃ⟩ //
gu⟨ṇau pṛ⟩
4 thagg=rūpayutau yācanāyuktisaṃguṇāḥ //
guṇa(gh)nena guṇe(n)ai⟨va⟩
5 rūpahīnena bhājitau /
viparītayācanākṣiptau guṇasāmye r=ayaṃ vidhiḥ //
ud⟨ā //⟩
6 evaṃ sūtraṃ // dvitīyapatre vivardhitāsti //

daśamasūtraṃ 10 // // //

7 sūtraṃ //
aṃśāṃ viśoddhya cchedebhya kuryā tatparivartanaṃ //
⟨cheda⟩
8 sāmyaṃ tatra projjhya dhanānvi śa vinirdiśet //
udā //
paṃcānāṃ vaṇijāṃ madhye ⟨maṇi⟩
9 vikrīyate kilaḥ
tatroktā maṇi vikrītā maṇimūlyaṃ kiyad=bhavet
(ta).(e)⟨□□
10 □□□□□□□□□□□⟩daṃ /
ardhatṛbhāgapādāṅśaṃ paṃcabhā⟨gaṣaḍaṃśa
11 kaṃ //
. . . ⟩

1–5. *Example 1 for Sūtra 9.* 6–11. *Sūtra 10.* 12–13. *Example 1 for Sūtra 10.* 15–18. *Sūtra 11.* 18. dhanānvi > dhanāni. 19–27. *Example 1 for Sūtra 11.*

III 2 (1^v)

1^v 1 (. . .)

2 ⟨. . . chedasā⟩mya⟨ṃ⟩ tato projjhya / sadṛśaṃ kṛyate /

3 ⟨□□□□⟩ □⟨□⟩ (pra) □jāta⟨ṃ⟩

120	90	80	75	72	tatra projjhya jātaṃ 12(0) /
60	60	60	60	60	

(9)0 / ⟨80 /

4 75 / 7⟩2 / eṣāṃ yog(ī)kṛtaṃ jātā 437 a(t)o (ṣa)⟨ṣṭi

5 hīne⟩ śeṣaṃ 377 eśa maṇimūlyaṃ /
caturṇāṃ saṅkaśarvasvaṃ // prathamasya saṅkaardhaṃ
⟨60 //

6 90 /⟩ 80 / 75 / 72 caturṇāṃ yoga 317 prathamārdheṇa
śaṣṭhibhir=yutaṃ 377 prathama⟨sya

7 dhanaṃ //⟩ prathamadhanaṃ / tṛtīyacaturthapaṃcama
sya dhanaṃ sarvasvaṃ 347 dvitīyātṛbhāgaṃ (3)⟨0 /

8 yutaṃ⟩ (jā)taṃ 377 eśa dvitīyasya dhanaṃ bhavati //
puna prathamadvitīyacaturthapaṃ(ca)⟨masya

9 sarva⟩svaṃ 357 tṛtīyasya pādaṃ 20 eṣayutaṃ 377 eṣa
tṛtīya(sya) ⟨dha

10 naṃ bha⟩(va)ti // punar=api prathamadvitīyatṛtīyapaṃ
camaṃ 362 □□□□⟨□□□

11 □□□□⟩ □eṣa □⟨□□⟩ p⟨u⟩nar=a(p)i □□□⟨. . .⟩

III 3 (2^r)

2^r 1 sya dhanaṃ bhavati // atha pratha⟨masya kṛyate⟩

⟨120⟩
⟨90⟩
⟨80⟩
75
72

⟨yutaṃ jātaṃ 437 ataḥ pā⟩

2 tyaṃ śaṣṭhiḥ śeṣaṃ 377 // atha dvitīyasya

20
30
80
75
72

⟨t⟩ṛ(bh)⟨āgaṃ k⟩ṛ⟨yate

3 377 dhana⟩ṃ dvitīyasya bhavati // atha tṛtīyasya

1–25. *Example 1 for Sūtra 11.* 1. Traces of a line of writing and of an enclosure. 2. ⟨. . . about fifteen *akṣaras* before 'cheda.' 21. Upper half of enclosure lost. 23. 20 > 120.

2^r kr̥yate

1⟨20⟩
9⟨0⟩
(2)⟨0⟩
⟨75⟩
⟨72⟩

4 ⟨e⟩vaṃ 377 tr̥tīyasya dhanaṃ bhavati // caturthasya

kr̥yate

120
(9)⟨0⟩
(8)⟨0⟩
15
72

5 evaṃ 377 caturthasya dhanā bhavaṃti // paṃcamasya kr̥yate / sthā

6 panaṃ

120
90
80
75
12

evaṃ paṃcamasya 377 // eṣa maṇi mūlyaṃ pra(t)ye⟨kaṃ //⟩

7 // udā // //

anyonyaviditavibhavaṃ □

8 ⟨□□⟩ vaṇik⟨tra⟩yaṃ /

tr̥pā⟨dah⟩ī⟨na⟩ṃ □□(ma) □□.ī □ṃ □laṃ tathā /

□□⟨□⟩

III 4 (2^v)

2^v 1 ⟨. . . ⟩ □v⟨.⟩ □□□

2

⟨7 +⟩	⟨3 +⟩	⟨5 +⟩
⟨12⟩	⟨4⟩	⟨6⟩

⟨□□□□□□⟩ □□□□□□

aṃśāṃ

7 +	3 +	5 +
12	12	6
12	12	6

vi

3 ś⟨o⟩ddhya (sa) viś⟨o⟩dhayet riṇaṃ sthitaṃ / eṣā

4 ⟨kr̥⟩yate

19	7	11
12	4	6

kuryā tatparivartanaṃ

1–7. *Example 1 for Sūtra 11.* 1. Part of 'kr̥yate', '9', and '(2)' on 2^rF^1. Enclosure, except top-left part, lost. 3. Part of 'te' and '120' on 2^rF^1, and '15' and '72' on 2^rF^2. 7. Part of '(t)ye' on 2^rF^2. 8–17. *Example 2 for Sūtra 11.* 15. The two '12's' in the second cell of enclosure > 4. 17. Part of '12' in the first cell of enclosure on 2^vF^1.

2^v

12	4	6
19	7	11

che(da)⟨sāmyaṃ

5 kṛta⟩

2^v F^1 ṃ jātaṃ / asyaḥ

2^v

924	836	798
1463	1463	1463

projjhya jātaṃ | 924 | ⟨836⟩

6 ⟨79⟩8 | eṣāṃ yutiṃ kṛyate / □□

7 ⟨□⟩ kṛtā jātā / 2558 // ccheda projjhyaṃ 1095 etan=maṇimūlyaṃ //

III 5 (3^v)

⟨dvitī

3^v 1 ya⟩sya hayā nnavaḥ
ūṣṭhrā daśa tṛtī(ya)⟨s⟩ya
□⟨□□⟩ □⟨□□□□/
□□□□□□□□⟩

2 pradattaṃ ca parasparaṃ /
pṛthag=dhanaṃ tu vaṇijāṃ
mūlyaṃ vā prāṇināṃ pṛthak
ya(ta)⟨ḥ śakyaṃ

3 tvayā⟩ vaktuṃ
tato me cchindhi saṃśayaḥ //

7 a	9 ha	ū 10
	1	1

vaṇijakā 3

d⟨e⟩ya⟨ṃ

4 va⟩ṇikpiṇḍahataṃ / piṇḍa 7 / 9 / 10 / deyaṃ 3 śuddhaṃ śeṣaṃ 4 / 6 / 7 / (e)te(ṣā)⟨ṃ

5 pa⟩rasparakṛtaṃ guṇita jātaṃ 168 / 168 / 168 / svaśeṣeṇa tu (v)i⟨bhaktaṃ / kṛtaṃ⟩

6

⟨1⟩68	168	168
4	6	7

labdhaṃ 42 / 28 / 24 / eṣa pra tyaikamūlyaṃ ekaikasya ⟨svapiṇḍena⟩

7 (g)⟨u⟩ṇitā jātāni aśvai hayai ūṣṭhrībhyaḥ 294 / 252 / 240 / e⟨teṣāṃ yo

8 gaṃ tribhir=vibha⟩k⟨ta⟩ṃ jātā 26⟨2⟩ / 262 / 262 / ete samadhanā ⟨jātāḥ //⟩

1–7. *Example 2 for Sūtra 11.* 6. Part of 'kṛtā' on 2^{v}F^2. 7. The remaining two-line space on 2^v is left blank.
8–30. *Example 1 for Sūtra 13.* 21. piṇḍa 7 > paṇya 7. 25. Left side of enclosure lost.

3^{v} F[1] 1 □□(ta) □
F[2] 1 kai

III 6 (3^{r})

3^{r} 1 (. . .)
2 ⟨□□□/
da⟩tvā ssamadhanā jātā
prastamūlya⟨ṃ⟩ tad=ucyata //

(4) tā	5 go	6 śā	e
1	1	1	

3 ⟨□□⟩ □prastamūlyaṃ 2 / 3 / 6 / dattais=samadhanā jātā 17 / 17 / 17 // ⟨tra
4 yodaśama⟩(sū)tra⟨ṃ⟩ 13 // //
sūtraṃ //
ekayutā narasaṃkhyā (dv)i⟨□
5 □□□□□⟩ .ī □ca //
evaṃ tāvat=kāryaṃ yāvat=puruṣai samā bhavati ⟨//
6 □□□□pa⟩tre bhilikhita sthitaḥ
caturdaśamasūtraṃ 14 // ⟨//
7 sūtraṃ //⟩
(ga)tisyaiva viśeṣaṃ ca vibhaktaṃ pūrvagantunāḥ
tenaiva kālaṃ bhavati ssa⟨me
8 na gati⟩(k)⟨e⟩na tu //
udā //
addhyardhayojana(ga)⟨t⟩e śata haṃta s⟨. □□□
□□□□⟩
9 (. . .)

3^{r} F[1] 1 (. . .)
F[2] 1 (. . .)
F[3] 1 (. . .)
F[4] 1 (. . .)

3–10. *Example 2 for Sūtra 13.* 11–16. *Sūtra 14.* 17–20. *Sūtra 15.* 21–24. *Example 1 for Sūtra 15.*

III 7 (4^r)

4^r 1 dv⟨i⟩tīya □□d. □□□⟨. . .
. . .⟩
2 yojanapaṃcakaṃ / saptadināni tasyaiva gatasya /
parat⟨o⟩ dvitīya navay⟨o⟩janika(ḥ) /
ta k(ai)
4^r F^1 (di)⟨nais⟩=(s)⟨ā
4^r 3 mya⟩tā /

1 di	5 yo	dina 7	gatasya
1	1	1	

gatayojana 35	dvi	1 di	9 yo
1		1	1

gatisyaiva viśeṣaṃ ca ka⟨□
4 □⟩ ghate / gati 5 / 9 / viśeṣaṃ 4 vibhaktaṃ

1/4 pūrvagata 35 eṣa pādair=guṇitaṃ 3⟨5⟩/⟨4⟩

5 (e)bhir=dinai samagatī bhavanti navayojanaṃ // pratyaya
trairāśikenaḥ

1 di	5 yo	35	⟨pha 175⟩
1	1	4	⟨4⟩
1 di	9 yo	35	pha 3⟨15⟩
1	1	4	⟨4⟩

6 ⟨//⟩ udā //
aṣṭhādaśayojanā ekena dine yāti / tasyāṣṭhadi
7 ⟨na⟩(ga)tasya / dvitīya paṃcaviṃśayojanā yāti /
kena kāle⟨na ga⟩
8 (t)⟨i⟩sāmyatāṃ //
evaṃ ekādaśamapattre bhilikhita pūrve pi //

paṃcadaśamasūtraṃ 15

9 ⟨sūtraṃ //
ādy⟩or=viśeṣa kartavyaṃ uttarasya viśeṣataḥ
vibhaktaṃ m=uttare
10 ⟨□□□□□□□□□□/

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1. *Example 1 for Sūtra 15*? 2–14. *Example 2 for Sūtra 15.* 5. Part of 'k(ai)' on 4^rF^1. 10. Part of 'ṣaṃ ca ka' on 4^rF^1. 12. Right half of the second enclosure lost. 14. The fourth cell of the first row lost. 'pha 3' of the second row on 4^rF^2. 15–21. *Example 3 for Sūtra 15.* 22–25. *Sūtra 16.*

4ʳ □□□□padaṃ h⟩īṇa sāmyaṃ ga⟨t⟩i⟨sya □□□/ . . . ⟩

III 8 (4^v)

4^v 1 (. . .)

4^v F[1] 2 ⟨aṃ⟩taraṃ

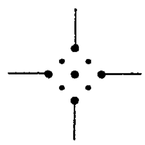
4^v 2/1 vibhaktaṃ 1/2 ādiśeṣa 2/1 jātā 1/1

dviguṇaṃ 2 rūpasaṃyutaṃ 3 eṣa (pa)

3 ⟨daṃ⟩ saṃkalite pratyayaḥ padaṃ hīṇāḥ ubhaye sthā pitavyā / rūpoṇākaraṇe phalaṃ 2⟨1⟩/21 ⟨□

4 □⟩ (pūrv)e (v)iṃ(śa)dgate pi likhite //

ṣoḍaśamasūtraṃ 17
sūtre bhrāntim=asti



5 ⟨sūtraṃ⟩

4^v F[2] // (ā)

4^v dyor=viśeṣa dviguṇaṃ
cayaśuddhirvibhājitaṃ //
rūpā⟨dh⟩i⟨kaṃ

6 yadā kā⟩

4^v F[2] (la)ṃ

4^v gatisāmyaṃ tadā bhavet //

// udā //

dvayāditṛcayaś=caiva (dv)i⟨tīyā

7 di⟩trikonnaraḥ

dvayo ca bhavate paṃthā kena kālena sāmyatāṃ //

sthāpanaṃ kṛyate / □⟨□⟩

8

⟨ā 2⟩ ⟨1⟩	⟨u⟩ 3 ⟨1⟩	pa 0 1	dvi	ā 3 1	u 2 1	pa 0 1

karaṇaṃ / ādyor=viśeṣa ⟨dvigu

9 ṇaṃ /⟩ (. . .)

1–10. *Example 1 for Sūtra 16.* 5. '2' in the first enclosure on 4^vF^1. 10–17. *Sūtra 17.* 17. Part of 'ga' on 4^vF^2. 18–25. *Example 1 for Sūtra 17.* 23. Left sides and bottom lines of the first three cells lost.

III 9 (5[r])

5[r] 1 □□k⟨.⟩ □t⟨. □⟩.r.□□□□□⟨. . .⟩

2

ā 5	u 6	pa 0	dha 0
1	1	1	1
⟨ā⟩ 10	u 3	pa 0	dha 0
⟨1⟩		1	1

karaṇaṃ / ādyaviś⟨e⟩ṣa ādi 5 / ⟨10⟩ / (viśeṣa) ⟨5⟩

3 cayaśuddhi cayaṃ 6 / 3 / śuddhi \3/ ādiśeṣa 5

4 dviguṇaṃ 10 uttaraviśeṣa 3 vibhaktaṃ (10 / 3)

sarūpaṃ (13 / 3) anena k⟨ālena⟩

5 samadhanā bhavantiḥ pratyayaṃḥ rūpoṇākarareṇa phalaṃ 65 | eṣa ⟨sama⟩ṃ ⟨dhanaṃ //⟩
[dvi 65]

(a)ṣṭhādaśamasūtraṃ 18 //

dinagamanam=ādirahitaṃ
⟨yad=dvi
7 gu⟩ṇaṃ tac=cottaraiṇa saṃyutaṃ /
pratinihita ātmaguṇaṃ
j⟨ātaḥ kṣe
8 pasaṃjñak⟩o ⟨rā⟩śi /
aṣṭhottaraguṇite kṣepasaṃjñako datvā
mūlaṃ p⟨ra⟩ti⟨n⟩i⟨hita
9 saṃyutaṃ ca
dviguṇottarabhājitaṃ ca //
□□⟩ □□□⟨□⟩ □□⟨□□□□□□□⟩

III 10 (5[v])

5[v] 1 ⟨. . . ṣaṭ paṃca⟩hata \30/

2 ⟨karaṇaṃ⟩ / dinagamanam=ādirahitaṃ
dinagamanayojanaḥ=pañca \5/ ādi

1–9. *Example 1 for Sūtra 18.* 1. ⟨. . .⟩ About 16 *akṣaras.* 2. Bottom left corner of enclosure lost. 10–19. *Sūtra 19.* 20–23. *Example 1 for Sūtra 19.*

5ᵛ

3 (3 / 1) rahitaṃ jātaṃ (2) dviguṇaṃ (4) tac=
cottareṇa saṃyutaṃ (8) ⟨pratini

4 hitaṃ⟩ (ātma)guṇaṃ (64) eśa kṣepasaṃjñako rāśiḥ aṣṭhottarasaṃgu⟨ṇ⟩i⟨te

5 la⟩bdharāṣi (30) aṣṭaguṇaṃ (240) uttareṇa guṇaṃ
uttaraṃ (4) ⟨a

6 nena⟩ guṇitaṃ jātaṃ (960) kṣepasaṃjñako datvā / tatra kṣepasaṃjña⟨ko⟩

7 ((6)4) y⟨u⟩taṃ (jā)taṃ (1024) asya mūlaṃ (32)
pratinihi(ta)⟨saṃyutaṃ

8 pratinih⟩i⟨ta⟩ṃ ((8)) y⟨u⟩taṃ jātaṃ (40) u⟨ttara⟩ṃ
((4)) ⟨dv⟩i⟨guṇaṃ⟩ ((8)) ⟨anena

9 bhājitaṃ jātaṃ⟩ ((5)) ⟨ebhir=dinaiḥ samādhvānaṃ // . . .⟩

III 11 (6ʳ)

6ʳ

1 (. . .) ⟨trairā⟩

2 śike pratyaya

1	5	5
1	1	1

phala⟨ṃ⟩ y⟨o⟩ (25) / ⟨p⟩ū⟨r⟩⟨va⟩
⟨gataṃ 30⟩

3 (a)nena ssaha 55 eśa samādhvānaṃ //
udā //
ādi paṃca uttaraṃ trī

4 ṇi naro yojana gamyate /
dvitīya pratidine ssaptagatasya ⟨di⟩

5 napaṃcakaṃ /
kena kālena samatāṃkatthyatāṃ gaṇakotta(ma //)
⟨nyāsaḥ⟩

6

ā 5	u 3	pa 0	pratigati 7
1	1	1	

dina (5)
paṃcadinaga⟨manaṃ sa

7 pta⟩y(o)janikaṃ yojana (35)

1–18. *Example 1 for Sūtra 19.* 15. (. . .) Traces of an enclosure. 19–28. *Example 2 for Sūtra 19.* 26. Left side and bottom lines for the first cell of the first enclosure lost.

6r karaṇaṃ / dinagamanam=ādirahi⟨taṃ⟩
8 tatra dinagamanaṃ (7) ādirahitaṃ / ādi (5)
rahitaṃ (jā)⟨taṃ⟩ (⟨2⟩) ⟨□□⟩
9 (...)

III 12 (6v)

6v 1 ⟨□□□□□□□□□□□⟩ □□□ (3) (a)nena
guṇita jātaṃ (84⟨0⟩)
2 ⟨kṣe⟩(pa)sa⟨ṃ⟩(jña)ko datvā / tatra kṣeparāṣi (49)
datvā jātaṃ (889) ⟨e
3 ṣa mū⟩(la) na dadāti samaṃ / karaṇī kṛyate / sūtraṃ //
akṛte śli⟨ṣṭakṛ
4 tyūnāc=cheṣa⟩cchedo dvisaṃguṇaḥ
tadvargaḥdala/saṃśliṣṭha/hṛti⟨śu
5 ddhiḥ kṛtikṣa⟩yaḥ
anena sūtreṇa śliṣṭhamūlaṃ ānayasva matimā⟨n=i
6 t⟩(i) labdhaṃ / mūlaṃ [29 / 48 / 58] pratinihitaṃ (7)

anena yutaṃ [36 / 48 / ⟨58⟩] ⟨sava
7 rṇa⟩ṃ k⟨ṛ⟩(ta)ṃ [2136 / ⟨58⟩] dviguṇottarabhājitaṃ /
tat⟨r⟩o⟨ttaraṃ⟩
8 (⟨3⟩) ⟨dviguṇaṃ⟩ (⟨6⟩) (an)e⟨na bhakta⟩ṃ [⟨356⟩ / ⟨58⟩]
⟨vartyaṃ jātaṃ⟩ [⟨178⟩ / ⟨29⟩] ⟨eṣa padaṃ // ...⟩

1–20. *Example 2 for Sūtra 19.* 6. Right half of enclosure lost. 10–13. *Sūtra Q2.* 16. Bottom part of enclosure lost. 17. Lower half of enclosure lost. 19–20. Enclosures lost.

III 13 (7^r)

7^r 1 ⟨□□□□□□⟩ | ⟨6 di⟩
⟨1⟩
⟨8 gha⟩
⟨60⟩
16 ca
60
33 li
60
6 vi
60
śe 6
29 | ⟨pratyayo rūpoṇākaraṇena /

padasaṃkhyā⟩ ⟨178⟩
⟨29⟩ ⟨rūpoṇā⟩

2 ⟨149⟩
⟨29⟩ ⟨uttaraghnā / tatrottaraṃ⟩ ⟨3⟩ ⟨guṇitaṃ jātaṃ⟩

3 ⟨44⟩7
⟨2⟩9 dalitā ⟨444⟩
58 (ā)di⟨saṃy⟩ut⟨ā⟩ tatr⟨ā⟩di ⟨5⟩ ⟨cheda⟩

4 sāmye yutaṃ 737
58 padaghnā / tatra padaṃ 178
2(9)

5 anena guṇitaṃ jātaṃ 65593
841 śli⟨ṣṭaṃ / kṛti⟩

6 pātya śeṣaṃ kṛyate / 65569
841 bhāge hṛte la⟨bdhaṃ⟩ ⟨77⟩
⟨28⟩
⟨29⟩

7 ⟨sama⟩(ga)tī(ś)u pratyayaṃ trairāśikena

1	7 yo	17⟨8⟩
1	1	⟨29⟩

⟨jā

1–12. *Example 2 for Sūtra 19.* 1-4. The first and second lines of writing lost, only the lower two thirds of the first enclosure preserved. 5. Enclosures preserved only partially. 10. Enclosure lost. 12. Right side and bottom line for the third cell of enclosure lost.

7r 8 taṃ⟩ phalaṃ yojana 42 śe | 28 / 29 | niyataṃ tena ⟨yu

9 taṃ jātaṃ phala⟩ṃ | 77 / ⟨28⟩ / ⟨29⟩ | e⟨k⟩o⟨na⟩viṃśatimas⟨ūtra⟩ṃ 19

III 14 (7v)

7v 1 ⟨. . . ⟩ □⟨□⟩ □⟨□⟩ l. □⟨□□□

2 □□□□p⟩rabhātmanaḥ

ā 3	u 4	pa 0	nitya datta 7
1	1	1	1

ādiṃ viśoddhya ⟨n⟩i⟨tyataḥ /

3 ādi⟩ \3/ niyataṃ \7/ viśeddhya \4/ uttarā

rdhena bhājitaṃ / uttaraṃ \4/ a⟨s⟩y⟨ārdhaṃ⟩ \⟨2⟩/

4 ⟨anena bhā⟩jitaṃ | 4 / 2 | jātaṃ \2/ labdhaṃ sarūpa /

eṣa rūpādhikaṃ \3/ eṣa kāla ⟨jñeyaḥ //

5 pratyayaḥ⟩

⟨ā⟩ 3	u 4	pa 3
1	1	1

rūpoṇākaraṇena

phalaṃ rū 21 // dvitīyasya trairā⟨śike

6 na pratyayaḥ⟩

1 di	7	3 di
1	1	1

pha rū 21 // eṣa sama dhanā

jātā //

7 ⟨udā //

ā⟩(dy=e)kaṃ uttara dvayaṃ
dvitīya paṃca pratyahaṃ /
kena kālena samatāṃ
⟨kathya

8 tāṃ ga⟩ṇakottama //

ā 1	u 2	pa 0	niyata nityaṃ 5
1	1	1	1

ādiṃ viśoddh⟨ya nitya

9 taḥ / . . . ⟩

1–2. *Example 2 for Sūtra 19.* 2. Lower half of enclosure lost. 3–14. *Example 1 for Sūtra 20.* 3. ⟨. . . ⟩ About 20 *akṣaras*. 8. The second enclosure lost. 11. Left half of the first cell of enclosure lost. 15–23. *Example 2 for Sūtra 20.* 21. nityaṃ > dattaṃ.

III 15 (8^r)

⟨viṃśatimasū
8^r 1 traṃ 20 //⟩ //
sū⟨t⟩ra⟨ṃ //⟩
dvi⟨g⟩u(ṇa)⟨ṃ⟩ prabhava⟨ṃ⟩ śuddha⟨ṃ⟩
dviguṇādi yath(ok)ta(ta)⟨ḥ /
u⟩
2 ttareṇa bhajec=cheṣaṃ
labdhaṃ rūpaṃ vinirdiśet //
udā //
va⟨rta
3 te⟩ bhṛtakaḥ=kaści
tatraiko daṣamāśakaṃ /
pratyahaṃ kurute tatra
karmaṃ (bha)⟨ḍ⟩i⟨la⟩
4 (m)ānavaḥ
dvitīyaṃ kṛyate karmaṃ
dvyāditṛtayaruttaraṃ /
padaṃ tatra ⟨tu na jñā
5 t⟩ā
kena kālena sāmyatāṃ //

ā 2	u 3	pa 0	prati 10
1	1	1	1

⟨karaṇaṃ /⟩
6 dviguṇaṃ prabhavaṃ śuddhā / prabhavaṃ \2/ dviguṇaṃ
\4/ niyata puna dvi⟨guṇaṃ⟩ \⟨20⟩/
7 ⟨□□□□□.⟩o ⟨□⟩ (jā)taṃ \16/ ut⟨t⟩arārdheṇa bhājayet
ut⟨t⟩are⟨ṇa bhajec che
8 ṣaṃ (. . .)

III 16 (8^v)

8^v 1 ⟨ekaviṃśatimasūtraṃ 21 //⟩

1–2. End of *Sūtra 20*. 3–8. *Sūtra 21*. 5. dviguṇādi yathoktataḥ > dviguṇān niyatāt tataḥ. 9–27. *Example 1 for Sūtra 21*. 24. The second enclosure lost. 25–26. 'uttarārdheṇa bhājayet,' deleted by attaching a short vertical stroke to each *akṣara*. 28. End of *Sūtra 21*.

8^v ⟨sūtraṃ //
hayair=vibhajya gantavyaṃ
ekarathe
2 śva⟩(sa)⟨ṃj⟩ñit⟨ai⟩ /
ekāścagamana jñ⟨e⟩(ya)⟨ṃ⟩
yukt⟨ai⟩s=sa⟨ṃg⟩u⟨ṇ⟩ya ⟨yojane //
u
3 dā⟩ //
niyo ratho śvai daśabhir=
yujyate hayapaṃcakaṃ /
gaṃtavyaṃ yoja(ṇa)⟨ṃ śataṃ
4 tatrai⟩ko śva kim=udbhavet //

ha 10 1	hayalagnarathasya 5 1	gantavyo yojana 1⟨00⟩ ⟨1⟩

⟨ka
5 raṇaṃ / ha⟩yor=vibhajya gantavyaṃ / tatra hayā \10/
gantavyaṃ yo \100/ ato bhāgaṃ ⟨hṛtvā
6 la⟩bdha \10/ tatra yuktāśva \5/ etais=saṃguṇya pariy-
oca jātaṃ \⟨50⟩/
7 ⟨eṣa⟩yojanāny=aiko śva rūḍhā / pratyayaḥ paṃcabhiś=śata
saṃguṇya jātaṃ \⟨500⟩/ ⟨trai
8 rāśikaṃ⟩ kṛyate // yadi daśāṣ⟨vā⟩ yojanāḫ=⟨p⟩aṃcaśata
⟨tadaiko śvaḥ kiyad=gacchatīti⟩
9 | ⟨10⟩ | ⟨500⟩ | ⟨1⟩ | ⟨phala⟩ṃ ⟨y⟩(o)⟨janāni 50 // . . . ⟩

III 17 (9^r)

9^r 1 ⟨tathā /
uttareṇa vibhājitaṃ
saikaṃ p⟩ra⟨ṣ⟩ṇ⟨ā⟩hva⟨yaḥ sa⟩ (ca //)
(u)dā (//)
2 ⟨□□□⟩ k. □□□□
(ta sa)māptaṃ dvijanmabhi /
tatpunas=te samaṃ bhaktvā
da⟨śai
3 kai⟩kas=samāptavān

1–6. *Sūtra 22.* 5. ekāśca > ekāśva. 7–23. *Example 1 for Sūtra 22.* 13. Right side of enclosure lost. 15. hayor > hayair. 18. Enclosure, except left side, lost. 20. Enclosure lost. 23. Enclosure lost. 24–26. *Sūtra 23.* 27–32. *Example 1 for Sūtra 23.*

9^{r} saṃkhyāyaḥ=kati mamācakṣva
kati viprāḥ=ka □□□ṃ ⟨//⟩

4

(ā) 1	u 1	pa 0	labdhaṃ 10
1	1	1	1

karaṇaṃ // labdhaṃ dviguṇitaṃ kṛtvā tat(ra) ⟨la⟩
5 bdhaṃ 10 dviguṇaṃ 20 tathā dvyūnaṃ $\begin{smallmatrix}18\\1\end{smallmatrix}$
6 ⟨uttareṇa⟩ v⟨i⟩bhājitaṃ / atrottaraṃ 1 anena bhaktvā jātaṃ tad=e⟨va⟩
7 $\begin{smallmatrix}\langle 18\rangle\\\langle 1\rangle\end{smallmatrix}$ ⟨sai⟩kaṃ $\begin{smallmatrix}19\\1\end{smallmatrix}$ ayaṃ praṣṇā brāhmaṇā ekonaviṃśati / sthāpa⟨naṃ
8 □.⟩ānayanaṃ /

ā 1	u 1	pa 19
1	1	1

rūpoṇākaraṇena phalaṃ 1⟨90⟩

III 18 (9^{v})

9^{v} 1 ⟨□□□⟩y⟨o⟩ja(n)⟨. □□⟩ □□(s)sara(tha)ga □⟨□□⟩ □ ⟨. . .⟩
2

⟨śī⟩ yo 6	śa yo 1	yo 70 gantavyaṃ
1	1	

adhvasaṃy⟨o⟩ga $\begin{smallmatrix}7\\1\end{smallmatrix}$ bha⟨k⟩ta⟨ṃ⟩ $\begin{smallmatrix}\langle 1\rangle\\7\end{smallmatrix}$ ⟨gantavyaṃ⟩
3 ⟨70⟩ ⟨ane⟩na guṇitā jātā r=labdha 10 dviguṇaṃ 20 eṣālpasyaḥ // atha ⟨□
4 □□□⟩ .ā ayaṃ kālo jñeyaḥ anena kālena ṣṣaṭyojanāni ā ⟨kra
5 mya tas⟩ya m=ekayojanikasya samāgamo bhavati // tad= yathā trairāśi⟨k⟩e⟨na pratya
6 yaḥ⟩ / yady=ekasya ṣaṭyojanā tadā viṃśānāṃ kiṃ

1	6 yo	2⟨0⟩
1	1	1

⟨pha yo⟩ $\begin{smallmatrix}\langle 120\rangle\\\langle 1\rangle\end{smallmatrix}$

1–11. *Example 1 for Sūtra 23.* 1. saṃkhyāyaḥ > saṃkhyā. 'ma' of 'mamācakṣva' falsely deleted. 3. Left side of enclosure seems not to have been drawn. Bottom lines for the first cell lost. 8. The first enclosure lost. 11. Enclosure, except left half, lost. 12–23. *Example 1 for Sūtra 24.* 13. ⟨. . .⟩ About 9 *akṣaras*. 15. Upper half of the second enclosure lost. 16. The first enclosure lost. 18. ṣṣaṭyojanāni > ṣaḍyojanikasya. 23. Right side of the first enclosure lost. The second enclosure lost.

9v 7 ataḥ⟩ saptati śodhya śeṣa atra ssaptati \70/ āgata paṃcāśa \50/ (a)tha ⟨dvi

8 tīyasya trairāś⟩i(ka)ṃḥ

1 di	1 yo	20 di
1	1	⟨1⟩

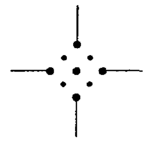
pha yo

(2)⟨0⟩
⟨1⟩

III 19 (10r)

⟨caturviṃśati

10r 1 mas⟩ūtra⟨ṃ⟩ (//)



⟨sūtraṃ //
kṛtvā rūpakṣayaṃ pā

2 r⟩tha⟨ṃ⟩
dhāntaś⟨o⟩ guṇana⟨ṃ⟩ tataḥ
pravṛtigu⟨ṇanenaiva
jātaṃ śeṣaṃ⟩

3 vinirdiśet //

udā //
tṛbhāgamaladandhasya
tṛdhāntasyaiva ⟨k⟩e⟨valaṃ /

4 a⟩ṣṭhottaraśatāni dattaṃ
kiṃ śeṣaṃ vada paṇḍita //

108	1	1	1
1	1	1	1
	3+	3+	3+

5 kṛtvā rūpakṣayaṃ pārtha jātā \32/ śeṣa // pra

6 thamadhvānte kṣayaṃ \36/ śeṣaṃ \72/ dvitīyadhvānte kṣayaṃ \24/ śe(ṣaṃ) \⟨48⟩/

7 tṛtīyadhvānte kṣayaṃ \16/ śeṣaṃ \32/ pratyayaṃ kṛyate / sthāpanaṃ

1–4. *Example 1 for Sūtra 24.* 3. Bottom lines of enclosure lost. 4. Enclosure lost. 5–6. End of *Sūtra 24.* 7–13. *Sūtra 25.* 14–24. *Example 1 for Sūtra 25.* 17. śatāni > śataṃ. 22. The second enclosure lost.

10ʳ 8

0	1	1	1	bhā śeṣaṃ 32	phalaṃ mūlā 108 //
1	1	1	1		
	3+	3+	3+		

atha pa⟨ṃca⟩

9 majātikṛyākaraṇaṃ .i □⟨□□⟩

10 ⟨108 1 1 3+ 1 3+ 1 3+⟩ ⟨phalaṃ 32 //⟩

III 20 (10ᵛ)

10ᵛ 1 ⟨punar anyaḥ⟩ | ⟨0 bhā śeṣaṃ 32⟩ | ⟨phalaṃ mūlaṃ

⟨1⟩
⟨1⟩
⟨3 +⟩
⟨1 ⟩
3 +
1
3 +

108 // □□□⟩

2 . . . / anyap⟩ra⟨t⟩ya⟨ye t⟩r⟨airāśi

3 kaḥ kṛyate / yadi śeṣam=e⟩(ka)⟨ṃ⟩ tṛbhi tryaṣṭhabhāga saṃyu(tai)⟨s=t⟩u

4 ⟨labdhaṃ⟩ tadāṣṭhottaraśatāḥ=kiṃ /

27	1	108	pha śe 3(2)
8	1	1	

5 ⟨□⟩ □⟨□□⟩ yady=ekasya traya ^sa^ trayaaṣṭha

6 bhāgā tadā dvātṛṅśānāṃ kim=iti //

1	3	32	phalaṃ 108
1	3		1
	8		

udā //

7 sakṛddhāntasya lohasya daśāṃśā kṣīyate s=trayaṃ / saptate dviguṇā

8 ⟨yā⟩ś=ca kiṃ śeṣaṃ vada paṇḍitaḥ //

3	140
10	1

1–14 *Example 1 for Sūtra 25.* 1. Bottom line of enclosure below '$\frac{0}{1}$' lost. 4. The numerals within the enclosure, which are lost, must have been rotated to the left by 90 degrees. Cf. III 26. 5. Upper two thirds of enclosure lost. 14. Bottom line for the second cell is round. 15–19. *Example 2 for Sūtra 25.*

10^v kṛtvā rūpakṣayaṃ pāstham=iti

9 ⟨tatra⟩ rūpaṃ 1 | 3/10 | kṣayaṃ kṛtvā jātaṃ śeṣa | 7/10 |
mūlaṃ

10 | ⟨14⟩0/⟨1⟩ | anena guṇitaṃ jātaṃ 98 kṣayaṃ 42 evaṃ
140 (pra)⟨tya

11 yas=trairāś⟩i⟨ke⟩na

7	1	98
1⟨0⟩	1	⟨1⟩

phalaṃ 140 //

III 21 (11^r)

11^r 1 ⟨p⟩(una) pratyayaḥ | 0, 1, 1, 3 +, 10 | ⟨bhā śe 98⟩ | ⟨phalaṃ mūlaṃ
140 //
udā //
adhyardha⟩

2 palākrīte palatṛbhāgaṃ kṣaya vrajati /
aṣṭhādaśa⟨palakrīte śe

3 ṣaṃ⟩ kathatāṃ brūhi //

| 1, 3, 3 bhā, 2 | 18, 1 |

karaṇaṃ / addhyardhapalaṃ cche⟨daṃ kṛtaṃ⟩

4 idaṃ | 2/9 | kṛtvā rūpakṣayaṃ rūpaṃ 1 kṣayaṃ kṛtvā
jātaṃ | 7/9 | 18/1 |

5 guṇitaṃ jātaṃ 14 kṣayaṃ 4 pratyaya trairāśikena
// addhyardhapala

6 krīte tṛbhāgaṃ kṣaya gacchati /
aṣṭhādaśapalakrītā kiṃ kṣayaṃ vada ⟨pa⟩

7 ṇḍita //

1–9. *Example 2 for Sūtra 25.* 4. Left half of the first enclosure lost. 6. Bottom line of enclosure lost. 7. Only the first two loops of the wavy line are preserved. 10–23. *Example 3 for Sūtra 25.*

11^{r}

1	1	18	phalaṃ 4
1	3	1	1
2			

puna tṛbhāgā divardhaṃ tadā catu⟨rbh⟩i

8 ḫ=kim=iti

1	1	4	phalaṃ 18
3	1	1	1
	2		

// udā //

caturbhāgamala⟨da

9 gdhaṃ suva⟩rṇaśatapaṃ⟨cakaṃ /

caturdhāntasya

10 tasyaiva kiṃ śeṣaṃ vada paṇḍita // ⟩

III 22 (11^{v})

11^{v} 1 ⟨pratyayaḥ kṛyate⟩

⟨500⟩	
⟨1⟩	
⟨1⟩	
⟨4	+⟩
⟨1⟩	
⟨4	+⟩
⟨1⟩	
4	+
1	·
4	+

⟨phalaṃ śeṣaṃ 158 to 1

śe⟩ ⟨1⟩ / ⟨64⟩ atha pratyaya ⟨k⟩ṛ

1–3. *Example 3 for Sūtra 25.* 3. Bottom line for the first two cells of enclosure lost. 4–10. *Example 4 for Sūtra 25.* 8. Existence of the tenth line of writing is not certain. 9. Upper two thirds of enclosure lost. Bottom corners are round. 10. Upper half of enclosure lost.

11^v 2 ⟨taṃ⟩

⟨0	bhā śe 158⟩
⟨1	1⟩
⟨1⟩	1
⟨4 +⟩	5
⟨1⟩	1
4 +	64
1	
4 +	
1	
4 +	

phala⟨ṃ⟩ mūlā 500 //

punar=eva prastārakra

3 maṃ //

500	1	1	1	1
1	1	1	1	1
	4 +	4 +	4 +	4 +

phalaṃ ś⟨e⟩

4 ṣaṃ sthāpyate d=iti

5 śeṣa 158 to 1 śe (1 / 64) anyaṃ caturthapratyayaṃ kṛya

6 te

0	1	1	1	1	bhā śeṣa 158
1	1	1	1	1	1
	4 +	4 +	4 +	4 +	5
					1
					64

phalaṃ

500 //

7 (anya)ṃ k⟨ṣ⟩a(ya)ṃ 125 śeṣaṃ 375 // dvitīye kṣayaṃ 93 to

8 ⟨3 m⟩āśa 9 śeṣa (281 / 1 / 4) kṣayaṃ (70 / 5 / 16) śeṣaṃ (210 / 15 / 16)

kṣayaṃ (52 / 47 / ⟨64⟩) ⟨śe

9 ṣaṃ⟩ (158 / ⟨13⟩ / ⟨64⟩)

11^v F eśa sa

11^v rvatra kartavyā //

1–13. *Example 4 for Sūtra 25.* 1. Upper half of enclosure lost. 6. Bottom corners of enclosure for '64' are round. 10. Bottom part of enclosure lost. 11. Enclosure, except upper part, lost. 12. Part of 'e' of 'eśa' on 11^v.

III 23 (12^r)

⟨udā //
12^r 1 □□
□□ca⟩tupra⟨s⟩tha □⟨□□□□□□□/
□□□□□□□□□□□
2 ma⟩dhunās=tathā /
aṃbhas⟨o⟩ v. g. k. y. ⟨□□⟩ .t. ⟨□□□□□□□//⟩

⟨1⟩	⟨1⟩	⟨1⟩	⟨1⟩	⟨4⟩
⟨1⟩	⟨1⟩	⟨1⟩	⟨1⟩	⟨1⟩
⟨4 +⟩	⟨4 +⟩	⟨4 +⟩	⟨4 +⟩	

3 kṛtvā rūpakṣayaṃ pāstam=iti tatra kṣayaṃ pāstam=iti tatra kṣayaḥ rū⟨pāt=pā⟩
4 tya śeṣaṃ

3	3	3	3	1
4	4	4	4	4
				1

gadyūti gadyūti gatvā ḥ=prasthaṃ pibet (ca)⟨tasrā⟩
5 gadyūti yojanaṃ / catuprasthai āḍhakaṃ / tadā dhāntaṣo r=gu
6 ṇātaḥ $\frac{81}{256}$ āvṛtti pravṛttir=guṇanena (jā)taḥ // 4 // anena g⟨u⟩
7 ṇ⟨i⟩taṃ jātaṃ $\frac{81}{64}$ eśa maddhva bhāgā hṛte labdhaṃ / mad-huprastu 1 ku ⟨1⟩
8 śe $\frac{1}{16}$ aṃbhabhāgā prastu 2 kuḍava 2 śe $\frac{15}{16}$ evaṃ (4) // (pra)⟨tyaya
9 bhu⟩ktiprakṣepake āḍhakā śoḍaṣa kuḍavā bhavanti / 16 / ato (ma)⟨dhu □
10 □□□⟩ □□□□□□□□□□□□(ś)e⟨ṣa⟩ṃ (12) (4) ⟨□□□□⟩

1–23. *Example 5 for Sūtra 25.* 7. Enclosure lost. 10. $\frac{1}{4} > \frac{4}{1}$, and delete '1' below it. 14. Delete 'guṇanena (jā)taḥ.' 22. The first enclosure, except upper part, lost. The second enclosure, except upper-left part, lost.

III 24 (12^v)

12^v 1 ⟨. . .⟩ 16 eṣa (ma)⟨□□

2 □□□□□□□□□□⟩ r.⟨p⟩ra⟨s⟩tha⟨k⟩uḍavā / 4 / 3 / śeṣa catvāra

3 kuḍavaḥ

2	2
1	1
4	4 +

śeṣā cakuḍavā pītā / ma

7	9
1	1
4+	4

puna cat⟨v⟩āra

4 ⟨k⟩u(ḍav)ā bhuktaṃ śeṣaṃ

81	175
16	16

jalabhāgaṃ / madhukuḍava

5
⟨1⟩

5 jalakuḍavo

10
1

śe

15
16

evaṃ kuḍava 16 //

// udā //

datvā śulkaṃ

6 caturbhāgaṃ aṣṭau āṇīta kuṃkumāṃ /

catuśulkaśālais=tu kiṃ śeṣaṃ vada

7 ⟨pa⟩ṇḍita //

8	1
1	1
	4 +

karaṇaṃ / kṛtvā rūpakṣayaṃ pāstaṃ / pāstaṃ

8	3
1	4

guṇi

8 ⟨taṃ jāta⟩ṃ 6 śulke 2 śeṣaṃ

6	1
1	1
	4+

anena gu⟨ṇi

9 taṃ jāta⟩ṃ

4	kṣayaṃ 1
⟨1⟩	1
⟨2⟩	2

śeṣena

4	1
1	1
2	4+

datvā

guṇita jātā

27
⟨8⟩

⟨□□□⟩

10 (. . .)

1–8. *Example 5 for Sūtra 25.* 4. Bottom corners of the first enclosure are round. 7. Enclosure, except upper-left part, lost. 9–21. *Example 6 for Sūtra 25.* 12. catuśulka- > caturbhiḥ śulka-. 19. Left half of the first enclosure lost. Its bottom right corner, which remains, is round. Bottom lines of the second enclosure lost.

III 25 (13r)

13r 1 □(k). bh. ⟨□□⟩ t. ⟨□□⟩ ⟨□□□□□□□□□□// pratyayaḥ kṛyate /⟩

2

(8)	1	1	1	1
(1)	1	1	1	1
	4 +	4 +	4 +	4 +

guṇita⟨ṃ⟩ jāta⟨ṃ⟩ $\frac{81}{32}$ //

⟨p⟩u⟨nān⟩ya⟨ṃ⟩	⟨8⟩	⟨3⟩	⟨3⟩	⟨3⟩	⟨3⟩
	1	4	4	⟨4⟩	⟨4⟩

3 phalaṃ $\frac{81}{32}$ phalaṃ // punānyaṃ

8 / 1 / 1 / 4+ / 1 / 4+ / 1 / 4+ / 1 / 4+	phalaṃ $\frac{81}{32}$ puna pratyayaṃ	8 / 1 / 1 / 4+ / 1 / 4+ / 1 / 4+ / 1 / 4+	bhā śe ⟨81⟩ 32

4 phalaṃ kuṃkuma 8 //
udā //
tṛbhāgaṣaḍbhāgapaṃcā
5 ⟨ṅśai⟩ guḍapiṇḍāṣṭhabhārakaṃ /
kiṃ śeṣaṃ dattabhir=bhavet //

6

8	2	5	4
1	3	6	5

guṇita jātaṃ $\frac{32}{9}$ etat=phalaṃ //

// u⟨dā //⟩
7 catuḥpaṃcakalābhena daśadroṇāt=pray(o)ji(t)⟨āt /
8 va⟩rṣai tṛbhis=tu kiṃ lābhaṃ gaṇakottama //

10	5	5	⟨5⟩
1	⟨4⟩	⟨4⟩	⟨4⟩

9 ⟨guṇita⟩ṃ ⟨jāta⟩ṃ $\frac{125}{\langle 64\rangle}$

1–7. *Example 6 for Sūtra 25.* 1. Enclosure, except bottom line, lost. 3. Bottom line of enclosure for '$\frac{(8)}{(1)}$' lost. 4. Left sides and bottom lines for the last two cells of enclosure lost. 8–12. *Example 7 for Sūtra 25.* 13–17. *Example 8 for Sūtra 25.* 16. Bottom lines of enclosure lost. 17. 125 > 1250. Lower half of enclosure lost.

III 26 (13^v)

13^v 1 (...)

2 ⟨...⟩ | ⟨10⟩ 1 1 4 1 4 1 4 | phalaṃ dro 19 (ā) ⟨2

3 pra 0 ku 2 // ayaṃ⟩ | ⟨0 bhā lā dro 19⟩
⟨1 1⟩
⟨1⟩ ā 2
4 4 dro
1 pra 0
4 4 ā pra
1 ku 2
4 ku 4 prasthi

(phala)⟨ṃ⟩ 10 // //
1

udā //
kasya⟨ci

4 vāṇi⟩jjakasya ṣaṣṭhi
svadalena kṣayaṃ ga⟨tā /

5 p⟩u(na v)ṛddhyā tṛbhāgena
svapādena tatojjhitaṃ /
v⟨ṛ⟩

6 ddhyā tu paṃcabhāgena
s=tathā vṛddhidvayo gataṃ /
kā vṛddhi vy⟨ā

7 ptā vāṇ⟩ijye
kiṃ vā śeṣaṃ tad=ucyatāṃ //

60	1	1	1	1
	1	1	1	1
	2 +	3	4 +	5

rūpalā⟨bha

8 kṣayena jā⟩tā 36 // pratyayaṃ punāsyaiva

1–4. *Example 8 for Sūtra 25.* 2. ⟨...⟩ About 19 *akṣaras* lost. Left side of enclosure corresponding to the first row lost. 3. Both sides of enclosure corresponding to the upper three rows lost. 5–19. *Example 9 for Sūtra 25.*

13^{v} 9

⟨0⟩	⟨1⟩	1	1	1	bhā	36	phalaṃ 60 //
⟨1⟩	1	1	1	1		1	
	⟨2⟩+	3	4 +	5			

punānyaṃ pratyayaṃ | 60 1 1 2 + 1 ⟨3⟩ ⟨1⟩ ⟨4 +⟩ ⟨1⟩ ⟨5⟩ | phalaṃ 3⟨6 //

10 punānyaṃ pratyayaṃ⟩ (a)syaiva mūlaṃ na jñāyate

0	1	1	2 +	1	3	1	4 +	1	5	pha⟨la⟩ṃ ⟨60 //⟩

III 27 (14^{r})

14^{r} 1 nite dhan⟨e⟩ /

yasya tanmayatāṃ cakṣva

sa⟨m⟩ya⟨k⟩ ta(d=a)tha m⟨e⟩ vadaḥ

⟨1⟩	⟨1⟩	⟨1⟩
(3)	⟨4⟩	⟨5⟩

2 apahṛtaśulkapiṇḍaṃ 24 //

karaṇaṃ // kṛtvā rūpakṣa

3 (yaṃ) pāsta

2	3	4
3	4	5

jātu saṃguṇya jātaṃ $\frac{2}{5}$

etāvad=api rūpasaṃśu

4 ddhā jātaṃ $\frac{3}{5}$ anena bhaktvā śulkapiṇḍaṃ guṇitaṃ

jātaṃ 40

5 eśa piṇḍaṃ pratyayaṃ

2	40
5	1

guṇita jātaṃ 16 śeṣaṃ

/ 24 / ⟨yu⟩

1–4. *Example 9 for Sūtra 25.* 1. Bottom line of enclosure below the first two columns lost. 2. Lower half of enclosure lost. 4. Lower line of enclosure lost. The numerals in the enclosure have been rotated to the left by 90 degrees. Cf. III 19. 5–16. *Example 10 for Sūtra 25.* 8. Vertical lines of enclosure, except left side, lost.

14r 6 taṃ \40/ / anyaṃ asya pratyayaṃ | 40 1 1 3 + 1 4 + 1 5 + | phalaṃ 16

kṣayaṃ 2⟨4 /

7 e⟩vaṃ \40/ // //

udā //

guḍapiṇḍajñātatulyoś=catur⟨bh⟩i

8 ⟨□⟩ □khya guḍaṃ /

tṛcatuḥpaṃcaṣaḍvṛddhyā catvāriṃśa vekṣaḥ ⟨□⟩

9 (. . .)

III 28 (14v)

14v 1 ⟨. . . ⟩ | ⟨□⟩ ⟨□⟩ 3 | (a) □⟨□□□□□□□

2 □□//⟩

udā //

ajñātarambhal⟨o⟩hasya

tṛcatuḥpaṃcakākṣayai /

sapta

3 viṃśati piṇḍasya

tṛdhāntaśeṣasya dṛṣyate /

kiṃ sarvaṃ vada tatvajña

kṣayaṃ ca ma

4 ma katthyatāṃ //

1	1	1	śe 27
3	4	5	1

karaṇaṃ / kṛtvā rūpakṣayaṃ pāstha

2	3	4
3	4	5

5 guṇitaṃ jātaṃ | 2 5 | rūpakṣayaṃ | 3 5 | anena śeṣaṃ

bhaktaṃ śeṣaṃ \27/ (bha)

1–3. *Example 10 for Sūtra 25.* 4–10. *Example 11 for Sūtra 25.* 6. khya?vye? 9. ⟨. . . ⟩ About 14 *akṣaras* lost. Upper part of enclosure lost. 11–23. *Example 12 for Sūtra 25.*

14^v 6 ⟨kta⟩ṃ jātaṃ 45 asya saptāviṃśa pātya śeṣaṃ 18 // eta
kṣayaṃ //
udā //
7 ⟨pa⟩rikṣīṇasya lohasya tṛdhāntaṃ paṃcamāśakaṃ /
na jñāyate t=pravṛttikāṃ ⟨na
8 ca śe⟩ṣa pradṛśyate /
pravṛttiśeṣaṃyo piṇḍaṃ kevalaṃ viṃśati sthitaṃ /
a⟨jñā
9 tā k⟩āṃ pravṛttī syā kiṃ vā śeṣaṃ vadaśva me //

1	1	1
3	4	5

kṛt⟨v⟩ā r⟨ū⟩pa⟨kṣayaṃ pā
10 staṃ . . . ⟩

III 29 (15^r)

15^r 1 ⟨□□□□/
k⟩ṣayasya ca ⟨p⟩ra⟨v⟩ṛ⟨ttiś⟩=ca
□saḥ ⟨k⟩ṣa(ya)⟨□□□□/
□□□□□⟩
2 yaṃ kaści
yadi śakyas=tad=ucyatāṃ //
etan=me saṃśayaṃ prājña
ddhvānta(gu)⟨ṇe⟩
3 vicāraṇāḥ //

2	3	4	kṣa śe	32
3	4	5		1

karaṇaṃ // dhvānta saṃguṇya guṇi
4 taṃ jātaṃ $\frac{3}{5}$ rūpaṃ dadyā $\frac{8}{5}$ bhāge hṛte labdhaṃ
bhaktveti
5 jā(t)ā $\frac{5}{8}\ \frac{32}{1}$ phalaṃ 20 eśa sā pravṛtti / śeṣaṃ 12
(e)⟨ka⟩
6 t⟨t⟩ra 32 //

1–2. *Example 12 for Sūtra 25.* 3–12. *Example 13 for Sūtra 25.* 4. paṃcamāśakaṃ > paṃcamāntakaṃ. 7. śeṣaṃyo > śeṣayoḥ. 10. Bottom lines of enclosure lost. 13–28. *Example 14 for Sūtra 25.*

15^{r} paṃcaviṃśatimasūtraṃ // 25 //

III 30 (15^{v})

15^{v} 1 ⟨□□□□□ /
□⟨□⟩ □□□□□.y. k⟨ā⟩ pravṛtti bhav⟨e⟩t=sakh⟨e⟩ //

2

⟨1⟩	⟨1⟩	⟨1⟩	1	śe 16
3	3	3	3	1

karaṇaṃ // dhāntaśo ghātitaṃ tena / rūpa

3 kṣayaṃ kṛtvā jātaṃ

2	2	2	2
3	3	3	3

guṇitaṃ

16
81

bha(kte)

4

81
16

śeṣeṇa guṇaye / śeṣaṃ

16
1

guṇita jātā

(8)⟨1⟩
⟨1⟩

5 ⟨e⟩(ṣa) pravṛttir=ity=arthaḥ // athānyavidhi kalāsavarṇe /
catu⟨r⟩dhānta

6 ⟨sya⟩ lohasya
ekāśītiś=ca dattavān
kiṃ śeṣaṃ vada dharmajña
ya⟨d⟩i

7 ⟨ga⟩ṇite kṛtaṃ śramaṃ //

81	1	1	1	1
1	1	1	1	1
	3 +	3 +	3 +	3 +

phalaṃ śe 16 //

pu(na)

8 ⟨pra⟩(tya)yaṃ kṛyate // mūlaṃ na jñāyate ⟨/⟩

9

⟨0⟩	1	1	1	1	bhā śe 16
⟨1⟩	1	1	1	1	1
	⟨3⟩ +	3 +	3 +	3 +	

phalaṃ lohapala 81 /

1. The remaining three-line space on 15^{r} is left blank. 2–20. *Example 1 for Sūtra 26.* 4. Upper half of right sides for the first two cells of enclosure lost. 8. Right half of the last enclosure lost. 19. Enclosure, except right side and bottom line below the fourth '3 +' and 'bhā śe', lost.

III 31 (16^r)

16^r 1 ⟨. . .⟩

⟨1	bhā	1⟩	⟨śe 10⟩
⟨1⟩		⟨3⟩	⟨1⟩
2			

⟨karaṇaṃ /⟩

2 vibhakta⟨ṃ⟩ jāta⟨ṃ⟩ | 2 / 9 | śe 10 / 1 | dh⟨ān⟩(ta)⟨śo ghātitaṃ / rūpakṣayaṃ kṛtvā bhaktaṃ⟩

3 | 9 / 7 | anena guṇitaṃ jātaṃ | 90 / 7 | bhāge hṛte labdhaṃ 12 //

⟨śe⟩

4 (ṣa)ṃ | 6 / 7 | asya pratyaya trairāśikena

7	1	10	pha 12
6	1	1	6
	2		7

// //

5 udā //

mākṣikagghaṭakasyaiva
dvitṛbhāgapravardhi⟨taṃ /
dvi⟩

6 (t)īy⟨e⟩ dvipaṃcamo bhāgo
tṛtīye dvisaptako(dvardhaḥ
ca)tu⟨r⟩th⟨e dvi⟩

7 (na)vaṃ bhāgaṃ
evaṃ jāta palatrayaṃ /
babhūvā śaulkikai hṛtvā
⟨kiṃ

8 pū⟩rvaṃ vada paṇḍita //

2	2	2	2	śe 3
3	5	7	9	1

dhāntaśo y⟨uta

9 p⟩ātim=iti / kṛtvā (rūpa) □□.i ⟨□⟩

1–9. *Example 2 for Sūtra 26.* 1. ⟨. . .⟩ About 12 *akṣaras* lost. 2. Enclosure, except round bottom lines below '2' and straight bottom lines below '⟨3⟩,' lost. 10–24. *Example 3 for Sūtra 26*. 24. p⟩ātim > p⟩ātitam?

III 32 (16^v)

16^v 1 (...)

2 ⟨□ṣaḍviṃ⟩(śa)ti⟨mas⟩ū⟨t⟩ra⟨ṃ⟩ (26) //

idānī suvarṇakṣayaṃ vakṣyā
3 ⟨mi⟩ yasyeda⟨ṃ⟩ sūtraṃ //
kṣayaṃ saṃguṇya kanakās=tadyutin=bhā(ja)
4 y⟨e⟩t=tataḥ
saṃyutair=eva kanakair=ekaikasya kṣayo hi saḥ //
udā //
e
5 ⟨kadvitricatu⟩ssaṃkhyā suvarṇā māṣakai riṇai /
ekadvitṛcatussaṃkh⟨yā⟩
6 rahitā samabhāgatāṃ //
sthāpanaṃ kṛyate / eṣāṃ
7

⟨1⟩+	2 +	3 +	4 +
⟨1⟩	2	3	4

karaṇaṃ // kṣayaṃ saṃguṇya kanakā d=iti
8 kṣayena saṃguṇya jātaṃ / 1 / 4 / 9 / 16
9 ⟨□□□⟩ □□e(ṣā) / yuti 30 kanakāyuti 10 anena bhaktvā
la⟨bdhaṃ 3⟩

III 33 (17^r)

17^r 1 ⟨pratyayas=trairāśikena⟩

⟨10⟩	⟨30⟩	⟨1⟩	⟨pha māṣe 3⟩	⟨□□□□
⟨1⟩	⟨1⟩	⟨1⟩	⟨1⟩	
⟨10⟩	⟨30⟩	⟨2⟩	⟨pha māṣe 6⟩	
⟨1⟩	⟨1⟩	⟨1⟩	⟨1⟩	
⟨10⟩	⟨30⟩	⟨3⟩	⟨pha māṣe 9⟩	
1	1	1	⟨1⟩	
10	30	4	pha māśe 12	
1	1	1	1	

2 □□□□□□□□□□□□⟩

2. End of *Sūtra 26.* 3–7. *Sūtra 27.* 8–21. *Example 1 for Sūtra 27.* 14. Bottom lines for the first cell lost. 20. Enclosure for upper two and a half rows lost.

17ʳ 3 // udā //

ekadvitṛ⟨catussaṃkhyā⟩

4 (suva)rṇa projjhitā ime

māśakadvi

5 tṛbhāṃś=caiva catuḥpaṃcakarāṃśakaṃ

kiṃ kṣayaṃ //

1	2	3	4
1	1	1	1
2	3	4	5

kara

6 ṇaṃ / kṣayaṃ saṃguṇya kanakā eśa sthāpyate /

7

1	2	3	4
2	3	4	5

s=tadyutin=bhājayeta tataḥ harasāmye

kṛte yukt⟨āḥ⟩

8 ⟨1⟩63 / 60 saṃyutaiḥ=kanakair=bhaktvā tadā kanaka 10

anena bhaktv⟨ā⟩

9 jātaṃ 163 / 600 eśa ekaikasuvarṇasya kṣayaṃ // ⟨pratya

10 yas=trairā⟩śikena kar⟨t⟩avyā /

III 34 (17ᵛ)

17ᵛ 1

⟨10⟩	⟨163⟩	⟨1⟩	⟨pha 163⟩
⟨1⟩	⟨60⟩	⟨1⟩	⟨600⟩
⟨10⟩	⟨163⟩	⟨2⟩	⟨pha 163⟩
⟨1⟩	⟨60⟩	⟨1⟩	⟨300⟩
⟨10⟩	⟨163⟩	⟨3⟩	⟨pha 163⟩
⟨1⟩	⟨60⟩	⟨1⟩	200
⟨10⟩	163	4	pha 163
1	60	1	150

⟨yutā jātā māṣāḥ⟩

⟨1630⟩ / ⟨600⟩ ⟨vartyaṃ jātaṃ⟩

2 ⟨163⟩ / ⟨60⟩ ⟨udā //

ekadvitricatussaṃkhyāḥ pañca

1–18. *Example 2 for Sūtra 27.* 10. bhājayeta > bhājayet. 12. Left side of the first enclosure lost. 16–19. The first two lines of writing on 17ᵛ, except the bottom row of the first enclosure, lost. 18–19. *Example 3 for Sūtra 27*.

17ᵛ 3 ṣaṭsaptakās=tathā
aṣṭau nava suvarṇānāṃ
4 pra⟩(māṇakā) sruṇusva m⟨e⟩
kram⟨e⟩ṇa dvaya(mā)
5 ṣādi uttare eka hīnatāṃ /
suvarṇaṃ te (ca)
6 sammiśrya katthyatāṃ gaṇakottama //
sthāpana⟨ṃ⟩

7

4 +	5 +	6 +	7 +	8 +	9 +	1 +	2 +	3 +
⟨5⟩	6	7	8	9	10	2	3	4

kṣayaṃ saṃguṇya
8 jātaṃ / (1)⟨2 /
9 20 /⟩ 30 / 42 / 56 / 72 / 90 / 2 / 6 / eśāṃ yuti 330 //
kana
10 ⟨kā⟩nāṃ yuti 45 / anena bhaktvā labdhaṃ (330 / 45)
paṃcadaśabhāge cche⟨d⟩i⟨te⟩
11 (⟨2⟩2 / ⟨3⟩) / phalaṃ (7 śe 1 / 3) eśa ekaikamāśakakṣayaṃ /
pratyaye trairā⟨ś⟩i
12 ⟨kaṃ kryate⟩

⟨45⟩	330	1	phalaṃ 22
⟨1⟩	1	1	⟨3⟩

evaṃ sarveṣāṃ prat⟨yayaḥ kartavyaḥ //⟩

III 35 (18ʳ)

18ʳ 1 ⟨saptaviṃśatimasūtraṃ 27

2 sūtraṃ //
aprāptasaṃguṇā kaṭī
śuddho hemaghnamā⟩
3 (ṣa)kaḥ
kā⟨ṃ⟩canai yad=bhave labdha⟨ṃ⟩
sa kṣay⟨ā⟩jñātamāśaka⟨ṃ⟩ //

1–19. *Example 3 for Sūtra 27.* 9. The last three cells should be placed in front, and the negative sign, '+', to the right of the lower numeral in each cell. 12. The numerals, '2' and '6,' should be placed before '12' in the previous line. 16. Left half of the first enclosure lost. 18. First cell of enclosure lost. 20. Ending mark for *Sūtra 27* mostly lost, only the lower vertical line being preserved. 21–26. *Sūtra 28.*

18r ud⟨ā //
māṣadva⟩
4 (y)āghrako prāpto
dvau ca prāptaṃ ca paṃcabhi /
trayaś=ca katibhiḫ=prāptā
ṣaḍ eva
5 ⟨tā⟩ni kevalaṃ /
caturbhir=māṣakair=hīnaṃ
kaṭi dṛṣṭhvāpnayā sakhe /
trayaś=ca
6 (ka)tibhiḫ=prāptā
suvarṇāṃ maśako vadaḥ //

1	2	3	6
2	5	0	4 +

karaṇaṃ /
7 aprāptasaṃguṇā kaṭī d=iti $\begin{smallmatrix}6\\1\end{smallmatrix}$
8 ⟨kaṭ⟩i (/ ca)tvāra 4 saṃguṇya jātaṃ 24 kāṃca
nāni tatojjhitaṃ / dvābhyāṃ
9 ⟨e⟩ka paṃcabhi dvayaṃ saṃguṇya jātaṃ 2 / $\begin{smallmatrix}10\\1\end{smallmatrix}$ /
tadyuti 12 / hit⟨v⟩ā ⟨.⟩e
10 ⟨□□⟩ hitva jātaṃ śeṣaṃ 12 / aprāptagaṇḍikai ta⟨.⟩i ⟨/ □
□□⟩

III 36 (18v)

18v 1 ⟨□□ □□⟩ | □□ | ⟨□⟩ | □⟨□□⟩ k⟨. □□⟩
(a)ṣṭhāvi⟨ṃ⟩śatimasūtra⟨ṃ⟩ (2)⟨8 //⟩

1–22. *Example 1 for Sūtra 28.* 3. (y)āghrako > yād eko. 13. A negative sign, +, should be placed to the right of '2' in the first cell and of '5' in the second cell. 23. End of *Sūtra 28*.

18^v 2 // sūtra⟨ṃ⟩
ūnais=saṃguṇya kanakā tatpiṇḍaṃ ca viśodhayet
su
3 varṇakanakābhyastā rāśiṣeṣaṃ vibhājayet
aprāptagaṇḍik⟨ā⟩
4 (m)āśaśuddhena kanakena tu
yal=labdhaṃ tat=pramāṇaṃ tu gaṇḍikāyā vini
5 ⟨rdi⟩śet //
udā //
ekadvitṛcatussaṃkhyā aprāptamāśakāni tu
6 (e)kadvitṛcatussaṃkhyā ekatrāvartitā kilaḥ
gaṇḍikājñ⟨āta
7 loha⟩kā ūnaikādaśamāṣakai /
aprāptajñātakanakai pram⟨āṇaṃ
8 paṇḍitāna⟩yaḥ

1	2	3	4	0
1	2	⟨3⟩	⟨4⟩	⟨11⟩

karaṇaṃ // ū⟨n⟩ai⟨s=sa⟩ṃ⟨guṇya
9 kanakā d=iti / . . . ⟩

1–8. *Sūtra 29.* 9–17. *Example 1 for Sūtra 29.* 16. Bottom lines, and lower half of the right sides of the last three cells, lost.

IV 1 (21ʳ)

21ʳ 1 ⟨. . .⟩ □
□(t)ṛt⟨ī⟩ya(di)⟨ne rūpaṃ
2 rūpam=a⟩rdhadine tath⟨ā⟩ //
tṛrūpa⟨ṃ⟩ pa⟨ṃ⟩cabhir=din(ai) /
teṣāṃ da⟨ttāni kair=dinaiḥ //⟩

3

⟨rū⟩ 1 1	rū 1 1	rū 3 1	dṛṣya 100 1
⟨1 di⟩ ⟨3⟩	⟨1⟩ d⟨i⟩ ⟨2⟩	5 di 1	

karaṇaṃ // (pari)⟨vartana⟩
4 ḫ=kṛtvā

3	2	3	dṛ 100
1	1	5	1

(pra)

5 ⟨kṣepayu⟩kt⟨y⟩ā / p⟨ra⟩k⟨ṣ⟩epay⟨ukti⟩ (⟨28⟩ / ⟨5⟩) bhaktaṃ
(5 / ⟨28⟩) dṛṣ(y)ena ⟨guṇitaṃ⟩

21ʳ F¹ 1 ⟨. . .⟩ □□□□⟨. . .
2 . . .⟩ kavaye ⟨. . .⟩
F² 1 ⟨. . .⟩ □□□⟨. . .
2 . . .⟩ □kā □⟨. . .⟩
F³ 1 ⟨. . .⟩ □□□□□⟨. . .
2 . . .⟩ paṃcasaṃ □ $\frac{1}{3}$ ⟨. . .⟩
F⁴ 1 ⟨. . .⟩ □□t. □□□□□⟨. . .
2 . . .⟩ udā //
rūpaṃ □⟨. . .⟩
F⁵ 1 t.g.t. □
F⁶ 1 □□

IV 2 (21ᵛ)

21ᵛ 1 (. . .)
2 ⟨□□na⟩vārdhaṃ tṛtīyasya jīvalokāt
eṣāṃ dīnāra⟨śataṃ dattaṃ paṃ
3 caka⟩(m)=⟨e⟩(k)⟨ai⟩kasya kiṃ bhavati //

21ᵛ

2 dī 1 2	3 dī 1 2	4 dī (1) ⟨2⟩	⟨dṛ 500⟩ ⟨1⟩
1 di 1 2	1 di 1 ⟨3⟩	1 (di) 1 4	

4 (pa)rivartanaṃ kṛyate // | ⟨10⟩ / ⟨6⟩ |

5

⟨2⟩1 ⟨8⟩	36 10	dṛ 500 1	prakṣe⟨payuktyā⟩

6 (. . .)

21ᵛ F1 1 | phala 1 □

F2 1 □5 | kasya

F3 1 7 | kṛyate

F4 1 □□ | .ṛ (dī 3) | d(i) 5 | (7)

F5 1 ⟨. . .⟩ (dinan.)⟨. . .

2 . . .⟩ □.i □⟨. . .⟩

F6 1 □□

IV 3 (22ʳ)

22ʳ 1

⟨100000⟩ 947	⟨157500⟩ (9)47	⟨216000⟩ (9)47	.⟨eṣāṃ yogīkṛtaṃ

jātaṃ⟩

2

□⟨□⟩ □	4(735)⟨00⟩ 947	⟨va⟩

3 rtita jātā phalaṃ 500 // asya pratyaya trai⟨rā⟩

4 śikena //

1–10. *Example 1 for Sūtra N7.* 1. ⟨. . .⟩ About 17 *akṣaras* lost. 6. Bottom lines for the first cell in each row, and right side of the first cell in the lower row, lost. 9. Enclosure lost. 10. Lower half of enclosure lost. 12. kavaye?kathaye? 22. (. . .) Traces of an enclosure as well as of a line of writing. 23–25. *Example 2 for Sūtra N7.* 1–4. *Example 2 for Sūtra N7.* 1. Enclosure for the last cell of the upper row, and bottom lines and right side of the lower row, lost. 2. Enclosure lost. 3. Bottom line of the first cell of enclosure lost. 12–16. *Example 2 for Sūtra N7* 12. Upper half of enclosure lost. 14. Right half of enclosure lost.

22r

2 dī 1 2	1 di 1 2	100000 947	phalaṃ di 60000 947
3 dī 1 2	1 di 1 3	157500 dī 947	phalaṃ di 60000 947
4 dī 1 2	1 di 1 4	216000 dī 947	phalaṃ di 600⟨00⟩ 94⟨7⟩

IV 4 (22v)

22v

1 (. . .)
⟨□□□
2 □□□□□
□□□□□⟩ □dvija /
ta dviguṇaṃ dvitīyasya
prathama⟨tra
3 yaṃ t⟩ṛtīyake /
prathamā caturguṇaṃ caiva
caturthe caiva dattavān
ca⟨tu
4 rṇāṃ ca⟩ dhanaṃ dattaṃ
śatam=ekaṃ dvayānvayaṃ //
vadasva prathame dattaṃ
kiṃ pramāṇaṃ ⟨pa
5 ra⟩sya ca //

0	2	3	4	dṛṣya 200
1	1	1	1	1

śūnyam=ekayutaṃ kṛtvā 1 / 2 / 3 ⟨/
6 4 // pra⟩kṣepayuktyā phalaṃ 20 / 40 / 60 / 80 / evaṃ 200
// eṣā⟨m a
7 paro v⟩i⟨dhi⟩ṃ

ā 20	u 20	pa 4
1	1	1

rūpoṇākaraṇena
phalaṃ 20⟨0⟩ //
8 // sūtraṃ //
yadṛcchāṃ vinyasye ś⟨ū⟩ṇ⟨y⟩e
(tad)ā (va)r⟨ga⟩ṃ ⟨tu kārayet / ⟩

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1. *Example 2 for Sūtra N7.* Bottom line for the first cell of the third row, and right side, of enclosure lost. 3–22. *Example 1 for Sūtra N8.* 23–25. *Sūtra N9.*

22^v 9 (...)

IV 5 (23^r)

23^r 1 (...)

2 □.ā □tṛguṇaṃ datta⟨ṃ⟩ t.y. □□⟨□□□□/
□□□□□□□□⟩

3 (p)rathamasya tu kiṃ bhavet //

0	tadā 2	tad⟨ā⟩ (3)	⟨tadā 4⟩	⟨dṛ 132⟩
1	1	1	⟨1⟩	⟨1⟩

4 yadṛcchāṃ vinyase śūnye

5 ⟨a⟩trecchā // 1 // tadā vargaṃ tu kārayet

1	2	2 3	6 4
1	1	1 1	1 (1)

6 p⟨ra⟩kṣipe guṇitaṃ // 1 / 2 / 6 / 24 /

7 (pra)kṣiptaṃ 33 // dṛṣyaṃ vibhajet 132 / 33 vartyaṃ
jātaṃ 4 / 1 15 □ ⟨pratha

8 me⟩ṇa dattaṃ // ato nyāsaḥ // 4 / 8 / 24 / 96 / e⟨vaṃ
132 //⟩

9 eṣa vargakramagaṇitaṃ // atha yutivargaṃ kṛ⟨yate //⟩

10 s⟨ū⟩t⟨ra⟩ṃ //
kāmikaṃ śūnye viṇyastaṃ tadā caiva krame guṇe /
□⟨□⟩

11 (...)

23^r F[1] 1 ———

F[2] 1 4
(1)

F[3] 1 □□□tta(?)

IV 6 (23^v)

23^v 1 ⟨...⟩ □□
□□kṛtvā caturtha⟨sya □□

2 □□□□□□/
□□⟩ □⟨□⟩ □□□.t. prathamasya tu kiṃ bhavet ⟨//⟩

3–15. *Example 1 for Sūtra N9.* 6. Enclosure for the last two cells lost. 9. '$\frac{4}{(1)}$' on 23^{r}F^2. 16–17. *Sūtra N10.* 20. Broken enclosure. 23–26. *Example 1 for Sūtra N10.* 23. ⟨...⟩ About 16 *akṣaras* lost.

23^v 3

⟨0⟩	2	3 3	12 4	dṛ 300
⟨1⟩	1	1 1	1 1	1

kāmikaṃ śūnye piṇyastaṃ ⟨/ kā⟩
4 mikaṃ 1 // eṣa ṇyastaṃ pra⟨thama⟩
5 rā(śiḥ) tadā caiva kramena guṇitaṃ / 1 / 2 / 9 / 48 / eṣāṃ yu⟨tiḥ kṛ
6 tā⟩ tha □ 60 anena dṛṣyaṃ bhājitaṃ | 1/60 | 300/1 |
jātā | 5/1 | e⟨ṣa pra
7 thama⟩(s)ya dhanaṃ // anena kṣepaṃ guṇaye / 5 / 10 / 45 / 240 / e⟨vaṃ 300 //
8 e⟩(ṣa) yutivargagaṇitaṃ // //
udā //
prathamasya na ⟨jā
9 nāmi⟩
kathaṃ ca dattaṃ vai dhanaṃ /
sa ced=v⟨ya⟩rdhaṃ ato dat⟨t⟩aṃ
.i ⟨□□□⟩ṃ ⟨□□□□//⟩
10 (. . .)

23^v F[1] 1

2
1

F[2] 1 (. . .)

F[3] 1 | □ |

IV 7 (24^r)

24^r 1 śataṃ catuścatvāl⟨iṃ⟩ś⟨ā⟩dhi⟨kasārdhaṃ
□□□□□□□□□□⟩
2 dattaṃ caiva caturguṇaṃ /
ki⟨ṃ⟩ prathamasya dha(na)⟨ṃ d⟩vi⟨jottama //
sthāpanaṃ /⟩
3

0 1	2 2	3 3	4 4	dṛ 144
1 1	1 1	1 1	1 1	1
2	2	2	2	2

⟨iṣṭāṅkaṃ vinyase⟩

1–10. *Example 1 for Sūtra N10.* 1. Bottom lines for the first two cells lost. '2/1', together with both sides, on 23^{v}F[1].
11–16. *Example 2 for Sūtra N10.* 21–27. *Example 1 for Sūtra N11.*

24ʳ 4 śūnye śta (1 / 1) ⟨□⟩

5 (yu)taṃ caiva guṇaṃ tataḥ yutaṃ caiva guṇaṃ kṛtvā kāraye (gu)ṇa⟨naṃ / dva⟩

6 (ye)na tu (5 / 2) guṇaṃ / upare uparaṃ adhe adhaṃ guṇaye (10 / 2) sārdhadva(ya)yutaṃ (1(5) / ⟨2⟩)

7 (tṛ)tīyarāśyā guṇaṃ / sārdhais=saptabhi trīṇi (45 / 2) sārdhatrayayuta⟨ṃ⟩ (⟨52⟩ / ⟨2⟩)

8 caturtharāśi guṇaye ṣṣaḍviṃśatibhi / jātā (208 / 2) sārdhacatvāriyu⟨tā jā

9 taṃ⟩ (⟨217⟩ / ⟨2⟩) ⟨eṣā⟩ṃ ⟨yu⟩(t)i (289 / ⟨2⟩) vi(bha)k⟨ta⟩ṃ d(ṛ)śyaṃ / sarvaṃ tad=eva jātaṃ ⟨// □□⟩

10 (. . .)

IV 8 (24ᵛ)

24ᵛ 1 ⟨. . . tṛtīye⟩(ṇa) tṛsārdhayu(taṃ)

2 ⟨ca dattaṃ tathā tadyuktaṃ ca⟩tu⟨r⟩guṇa⟨ṃ⟩ caturthena navārdhayutaṃ dattaṃ /

3 ⟨ekatraṃ ca dattaṃ dviśa⟩tā dvāviṃśādhikā kim=atra prathamasya dattāsīt ⟨//⟩

4

⟨0⟩ 3	2 5	3 7	4 9	ekatraṃ dattaṃ 222
⟨1⟩ 2	1 2	1 2	1 2	

śūnya

5 ⟨sthā⟩ne rūpaṃ datvā // 1 // yutaguṇitayutakrameṇa jātaṃ // sthāpa⟨naṃ⟩

6

⟨5⟩	⟨1⟩5	67	357	dṛṣya 222	prakṣepena jātaṃ
⟨2⟩	2	2	2	1	

222 // ⟨bha⟩

1–11. *Example 1 for Sūtra N11*. 5. The second enclosure lost. 7. Enclosure lost. 10. The first enclosure lost. Lower half of the second enclosure lost. 11. d(ṛ)śyaṃ > d(ṛ)śyaṃ jātaṃ (1). 13–24. *Example 1 for Sūtra N12*. 13. ⟨. . . About 15 *akṣaras* lost. 19. Bottom lines below '⟨1⟩' of the first cell lost. 23. Bottom line for the first two cells, and vertical line between them, of enclosure lost.

24^v 7 ktāḥ dṛśyāḥ 222 // jā(ta)⟨ṃ⟩ ⟨1⟩
8 ⟨□□□⟩ □□□□//
udā //
prathamaṃ na jānāmi /
divardhay⟨u⟩taṃ ⟨prathamaṃ
9 tadā dvigu⟩ṇaṃ (paṃcārdhay)⟨u⟩taṃ pratha(ma)⟨. . . ⟩

IV 9 (25^v)

25^v 1 ⟨□□□□□□□□⟩

⟨0 3⟩	⟨2 5⟩	⟨3 7⟩	⟨4 9⟩	⟨dṛśya 71⟩
⟨1 2⟩	⟨1 2⟩	⟨1 2⟩	⟨1 2⟩	⟨2⟩

2 karaṇaṃ śūnyasthān⟨e⟩
3 rūpaṃ datvā | 1 | yutā jātā | 5 / 2 | dva(y)⟨e⟩(na) ⟨g⟩u⟨ṇaṃ
paṃcārdhayutaṃ dvi⟩
25^v F tīya⟨sya⟩
25^v 4

5	15
⟨2⟩	2

prathamā tṛtīyasya tṛguṇaṃ yutaṃ jāta⟨ṃ⟩

| ⟨22⟩ / ⟨2⟩ | ⟨caturthasya catu⟩

5 rguṇaṃ navārdhayutaṃ jātaṃ | 29 / 2 | ekatra nyāsaḥ

5	15	(2)⟨2⟩
2	2	(2)

6

⟨2⟩9	dṛ 71
(2)	2

prakṣiptaṃ | 71 / 2 | bhaktaṃ dṛṣyaṃ
jātaṃ 1 /
7 anena sarva guṇitaṃ tad=eva

5	1⟨5⟩	22	⟨29⟩
2	2	⟨2⟩	⟨2⟩

8 (e)katraṃ

1–2. *Example 1 for Sūtra N12.* 1. Enclosure lost. 3–20. *Example 2 for Sūtra N12.* 8. Enclosure mostly lost, only bottom-left corner being preserved. 13. Bottom line for the first cell of enclosure lost. yutaṃ > saptārdhayutaṃ. 14. Enclosure lost. 16. Bottom line for the third cell lost. 17. Bottom line for the first cell of the first enclosure mostly lost. 19. Bottom line for the last two cells of enclosure lost. 20. (e)katraṃ > (e)katraṃ $\frac{71}{2}$. Space for 15 *akṣaras* is left blank after '(e)katraṃ.'

25ᵛ udā //
9 (e)ṣāṃ aparo vidhiḥ //
prathamadhanaṃ dattaṃ na jātaṃ
kiṃ tu divardhayutaṃ / tadā dvi⟨tīye
10 na⟩ (dvi)g⟨u⟩ṇaṃ dattaṃ paṃcārdhahīnaṃ /
tadā tṛtīyena tṛguṇaṃ dattaṃ sap⟨t⟩ār⟨dhahīnaṃ /
11 tadā la⟩bdhā caturthena caturguṇaṃ navārdhahīnaṃ
dattaṃ ekatraṃ ta⟨s⟩y⟨ai⟩(va) ⟨ca sā
12 rdhaviṃśatir=dattā prathame
k⟩iṃ (dat)⟨ta⟩ṃ dha⟨na va⟩da

2 5	3 gu 7	4 gu ⟨9⟩	⟨dṛ 41⟩
1 2 +	1 ⟨2⟩ +	1 ⟨2 +⟩	⟨2⟩

IV 10 (25ʳ)

25ʳ 1 ⟨□□□⟩

⟨0 3⟩	⟨2 5⟩	3 7 +	4 9 +	dṛ 78
⟨1 2⟩	⟨1⟩ 2 +	1 2	1 2	1

2 ⟨karaṇaṃ śū⟩
3 (ṇ)y⟨e⟩śu rūpa⟨ṃ⟩ dīyat⟨e⟩ / yutaṃ jātaṃ $\begin{smallmatrix}5\\2\end{smallmatrix}$
dvitīyaguṇaṃ $\begin{smallmatrix}10\\2\end{smallmatrix}$ pātya
4 $\begin{smallmatrix}⟨5⟩\\⟨2⟩\end{smallmatrix}$ tṛtī(ya) ekatraguṇitaṃ / yutena / yutaṃ /
$\begin{smallmatrix}10\\2\end{smallmatrix}$ $\begin{smallmatrix}23\\2\end{smallmatrix}$
5 ⟨pātya⟩ $\begin{smallmatrix}⟨3⟩0\\(2)\end{smallmatrix}$ yutaṃ / $\begin{smallmatrix}33\\2\end{smallmatrix}$ guṇitaṃ $\begin{smallmatrix}132\\2\end{smallmatrix}$ riṇaṃ
jātaṃ / pā(tya)
6 eśanyāsa

5	5	23	123	dṛṣya 78
2	2	2	2	1

e⟨ṣām=e

1–11. *Example 3 for Sūtra N12.* 3. jātaṃ > jñātaṃ. 11. Bottom lines, and both sides of the last cell, lost. 12–21. *Example 4 for Sūtra N12.* 13. Enclosure up to the middle of the second cell lost. 17. Enclosure, except part of right side, lost. 18–19. $\begin{smallmatrix}10\\2\end{smallmatrix}$ $\begin{smallmatrix}23\\2\end{smallmatrix}$ ⟨pātya⟩ $\begin{smallmatrix}⟨3⟩0\\(2)\end{smallmatrix}$ > $\begin{smallmatrix}10\\2\end{smallmatrix}$ guṇitaṃ · $\begin{smallmatrix}30\\2\end{smallmatrix}$ pātya · $\begin{smallmatrix}23\\2\end{smallmatrix}$. 19. Left half of the first enclosure lost. 20. jātaṃ / pā(tya) > pātya jātaṃ $\begin{smallmatrix}123\\2\end{smallmatrix}$.

25ʳ 7 katraṃ⟩ | ⟨15⟩6 / 2 | vibhaktavyaṃ | 2 / 1⟨56⟩ | 78 / ⟨1⟩ | □□□
(jā)⟨ta⟩ṃ | ⟨1⟩ | ⟨□□□⟩
8 (...)

25ʳ F 1 ———

IV 11 (26ʳ)

26ʳ 1 ⟨□□□□□□□□□⟩

⟨0 3⟩	⟨2 5 +⟩	⟨3 7 +⟩	⟨4 9 +⟩	⟨dṛ 29⟩
⟨1 2⟩	⟨1 2 +⟩	⟨1 2⟩	⟨1 2⟩	⟨2⟩

2 ⟨karaṇaṃ // śū(ṇya)⟨s⟩(th)⟨ā
3 ne⟩ rūpaṃ datvāḥ yutaṃ jātaṃ | 5 / 2 | p⟨ra⟩tha⟨mā dvitīyaṃ dviguṇaṃ paṃcārdhahī⟩
4 (na)ṃ | 5 / 2 | prathamā tṛtīyaṃ tṛguṇa⟨ṃ saptārdha rahitaṃ⟩ | ⟨8⟩ / ⟨2⟩ | ⟨pratha⟩
5 mā caturthaṃ caturguṇaṃ navārdharahitaṃ / śeṣaṃ | 11 / 2 | (e)ṣā ny⟨āsaḥ⟩
6

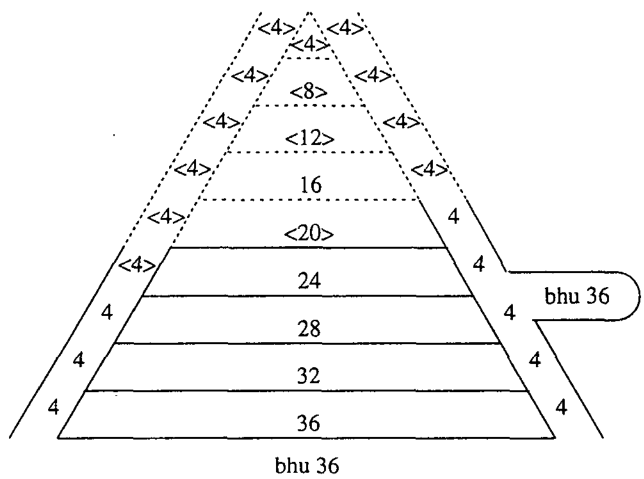
5	5	8	11	dṛ 29
2	2	2	2	2

prakṣepayuktiḥ | 29 / •2 | dṛśya⟨ṃ⟩ | ⟨29⟩ / ⟨2⟩ |
7 bhaktaṃ | 2 / 29 | | 29 / 2 | jātaṃ | 1 | ⟨a
8 ne⟩(na) guṇitaṃ tad=eva / evaṃ riṇarāśī bhavanti / tṛprakāraṃ
9 samāp⟨ta⟩ṃ //
ś⟨ū⟩ṇyasthāne rūpaṃ datvā tadanu yuktaṃ guṇita ⟨h⟩ī⟨naṃ
10 vā⟩ (...)

1–3. *Example 4 for Sūtra N12.* 1. Left side of the first enclosure lost. Bottom lines of the second and the third enclosures lost. 2. Enclosure lost. 4. Part of an enclosure visible. 5–17. *Example 5 for Sūtra N12.* 6. Enclosure, except bottom lines up to the middle of the second cell, lost. 11. Enclosure lost. 13. Part of 'ṣā ny' of '(e)ṣā ny⟨āsaḥ⟩' on 26ʳF[1]. 14. Part of 'dṛśya' on 26ʳF[2]. 15. Right half of enclosure lost. 20–22. *Sūtra N12.*

IV 12 (26^v)

26^v
⟨□□□□□□⟩ phala⟨ṃ⟩ (7) □⟨...⟩
atha dvau 4 / 3(6) / asya dalaṃ □⟨...⟩
athāṣṭha 8 / 32 / dalaṃ (20 pha)⟨...⟩
16 / 28 dalaṃ (pha)⟨...⟩
24 / 16 dalaṃ (pha)⟨...⟩
atha trīṇi tresārāda □⟨...⟩
36 / 20 / 4 / asya tṛ(ka) □⟨...⟩
32 / 20 / 8 / ato ccheda ⟨...⟩
28 / 20 / 12 puna □⟨...⟩
24 / 20 / 16 / □⟨...⟩



1–10. *Example 1 for Sūtra C5.* These statements are written to the right of the geometric figure.

V 1 (38#3^v)

40^v F^3 $^a1$ ⟨...⟩ (7) kṛtaṃ (1) ⟨...⟩

$^b1$ ⟨□⟩ □□□□□⟨□□⟩ □tya kṛtvā 3 □□□rbha guṇe tu /

eko rū⟨pa⟩

$^b2$ śatatrayaṃ /

paṃcabhiḥ=puruṣair=labdhaṃ

kim=ādyaṃ prathamaṃ dhanaṃ //

$^c1$ ‖ 120 ‖ d⟨ṛ⟩ (225) ‖ □□□ṃ □□□ṃ □□□□.i □.i ⟨...⟩

40^v F^8 $^d1$ ⟨...⟩ □□□□□□□□.y. □□□

39^v F^4 ⟨□⟩ □.t. □d.bh. □t. śśuddhā / □⟨...

$^d2$ ...⟩yet śeṣe kṣepaṃ 16 / 1 anenātra bhāga 32 / 16 labdhaṃ 2

$^e1$ ⟨...⟩ □□□20 □40 / 1 ⟨...⟩

$^f1$ ⟨...⟩ □d. ⟨...

$^f2$ ...⟩ va □⟨...⟩

$^g1$

⟨1⟩	⟨10⟩	10	pha (100)
⟨1⟩	⟨1⟩	1	
⟨1⟩	⟨10⟩	12	pha 120
⟨1⟩	⟨1⟩	1	

$^h1$ e □□labdher=bhāgaṃ 28 / 2 jātā 14 / 1 labdha kṣepaṃ vi⟨n⟩i⟨rdiśet ...⟩

38^v F^1 $^i1$ □□□

7	(9)	1(4)	dṛ 60
1	1	1	1

prakṣepayukti 30 vibhaktaṃ 1 / 30 dha(naṃ e)⟨ṣa 60

$^i2$ jātaṃ 2 anena pṛtha)(g=g)⟨u⟩ṇitā jātā 14 / 18 / 28 / ekāṃ 60 ⟨//⟩

40^v F^4 $^j1$ nyāsaḥ

---

17. Section (^{g}) seems to belong to V 4 (38#2^v). Enclosure up to the second column, and right side of the upper row, lost. 18–19. Part of 'bdha kṣepaṃ vi⟨n⟩i' on 38^{v}F^1. 20–23. *Example 9 for Sūtra N1.*

V 2 (38#3^r)

40^r F^3 1 (. . .) ⟨ma⟩

2 dhvāṃbupayaso ghaṭaḥ

ekamiśrīkṛta .ṛ □.r.k. □.y. □⟨□□□□□□□□□⟩

3 karaṇaṃ / dravyatulyaṃ vinikṣipyaḥ

4	5	6
4	5	6
4	5	6

kuru

prakṣepakaṃ tata / prakṣ⟨e⟩(pa)⟨yu

39^r F^4 4 k⟩(ti) saṃsthāpya

4 ma 15	5 aṃ 15	6 ⟨pa⟩ 15
4 15	5 15	6 15
4 15	5 15	6 15

pṛ

40^r $F^{3,8}$ thag=vadha

39^r F^4 pra⟨kṣepakaiḥ // □□□□□□□⟩

5 □tasya kṛyate // caturbhi paṃcabhiṣ=ṣaḍbhi gu⟨ṇaṃ⟩

16 15	20 15	⟨24⟩ ⟨15⟩
20 15	25 15	⟨30⟩ ⟨15⟩
24 15	30 ⟨15⟩	⟨36⟩ ⟨15⟩

6 (pra)thamarāśiyoga [60 / 15] vartyaṃ 4 / (1) madhūghaṭa /

38^r F^1 7 dvitīyapaṅtyā yogaṃ [75 / 15] vartyaṃ 5 / 1 pānīya //

tṛtīyapaṅtyā

8 kṛyate yogaṃ [90 / 15] vartyaṃ jātaṃ 6 / 1 payasaṃ /

[1 ma] □⟨□□□

9 □⟩ □□□ṃ □.i □ṃ // □□.i paṃ □□□□□⟨. . . ⟩

40^r F^3Un 1 ṣṛ □

40^r F^4 1 (p)ratha □□⟨. . .

2 . . . ⟩ □trayaṃ / (ka)⟨. . . ⟩

1–16. *Example 1 for Sūtra N13.* 4. Part of the second row of enclosure on 40^rF^8. Of the third row, '4' on 39^rF^4, and '5' and '6' on 39^rF^4 and 40^rF^8 6. 'ṃ' and '6' in the first row of enclosure on 40^rF^3. 10. Right side and bottom line of enclosure lost. '24,' '30,' and '15' of the third row on 38^rF^1. 15. Bottom part of enclosure lost. 17. Under leaf. 18. (p)ratha?(p)raṣa?

V 3 (38#2^{r})

39^{r}	F^{2}	1	□(d)ṛ(ṣ)ṭhv⟨ā⟩ kṣa □□□⟨□□□□□□□
			prathamasya bhāgo daśa dvitī⟩
40^{r}	F^{6}	2	(ya)sya tu dvādaśa / catu
39^{r}	F^{2}		rdaśa tṛtīyasya caturthasya ś⟨o⟩(ḍa)⟨śaiva⟩
40^{r}	F^{6}	3	(d)⟨ṛ⟩ṣ⟨ṭa⟩ṃ bhāgās=tasyaiva paṃcamasya
39^{r}	F^{2}		tu ṣṭhādaśa / ṣaṣ(ṭha)⟨kṣepam=a
40^{r}	F^{2}	4	thābh⟩āgā viṃśaś=ca daśagu
38^{r}	F^{3}		ṇā / saptamakṣepam=ajñātabh⟨āgaṃ tatra⟩
40^{r}	F^{2}	5	(tra)yaṃ śataṃ / sarvemiśrāpi dṛ
38^{r}	F^{3}		ṣṭhaṃ ca śatāni (dv)ādaśaiva ⟨ca
		6	□□□□⟩
40^{r}	F^{2}		ṃ □.i □.o ⟨□□⟩
38^{r}	F^{3}		□.o □□⟨. . .⟩
39^{r}	F^{7}	1	5 | 9 kṣa / 15 | 15
			□□□ṃ ⟨□□⟩ □

V 4 (38#2^{v})

39^{v}	F^{2}	1	⟨. . .⟩ (. . .) ⟨. . .
		2	□□□□□□□⟩ □□dhana⟨ṃ⟩ 1 / 1 ⟨□□□□⟩ □(e)ṣa 10 // eṣa
			ekaikabhāgāguṇitā jā⟨tāḥ
		3	100 / 120 / 140 /⟩ 160 / 180 / 200 / 300 / evaṃ dhanaṃ
			1200 / 1
40^{v}	F^{6}		pratyayas=trairā⟨śike⟩

1–13. *Example 1 for Sūtra C6.* 3. Part of 'dvādaśa / catu' on $39^{r}F^{2}$. 5. Part of 'masya' on $39^{r}F^{2}$. 7. Part of 'viṃśaś ca daśagu' on $38^{r}F^{3}$. 8. Part of 'ṇā / saptamakṣepa' on $40^{r}F^{6}$. 9. Part of 'dṛ' on $38^{r}F^{3}$. 16–21. *Example 1 for Sūtra C6.* 19–20. Part of 'vaṃ dhanaṃ 1200 / 1' on $40^{v}F^{6}$.

39^v F^4 4

⟨1⟩	⟨10⟩	10	pha (100)
⟨1⟩	⟨1⟩	1	
⟨1⟩	⟨10⟩	12	pha 120
⟨1⟩	⟨1⟩	1	
⟨1⟩	⟨10⟩	⟨14⟩	pha 140
⟨1⟩	⟨1⟩	1	
⟨1⟩	⟨10⟩	16	pha 160
⟨1⟩	⟨1⟩	1	
⟨1⟩	⟨10⟩	(18)	pha 180
⟨1⟩	⟨1⟩	1	
⟨1⟩	⟨10⟩	20	pha 200
⟨1⟩	⟨1⟩	1	
⟨1⟩	⟨10⟩	⟨30⟩	⟨pha 300⟩
⟨1⟩	⟨1⟩	⟨1⟩	

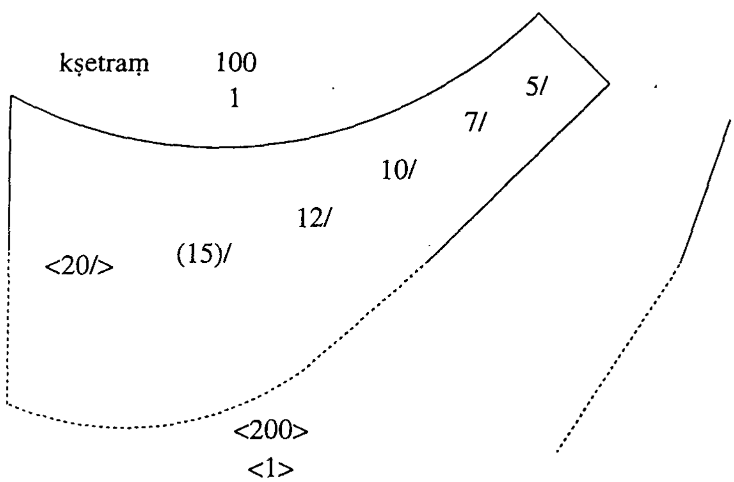
39^v F^2 ⟨e⟩vaṃ dhanaṃ 1200
40^v F^6 //

V 5 (38#1^r)

⟨sūtraṃ //
□□□□□□□□□□□□
40^r F^1 1 □niś⟩caya⟨ṃ⟩ /
yatra y⟨o⟩ga⟨ś⟩=ca ⟨ta⟩dbhāga⟨ṃ □□□□□□□□/
□□□□□□□□⟩
2 ta⟩dbhāgaṃ caiva kārayet
kṣetravaipulyaḥ r. □□.t. □.y. ⟨□□⟩ □⟨□□//⟩
3 ⟨ud⟩ā //
pṛṣṭhā śatadvayaṃ caiva
udare śatam=ekataḥ
vaipulyā
40^r F^5 d=vi⟨ṃśa paṃ
39^r F^1 4 ca⟩(da)śa
dvādaśan=daśakas=tathā /
sapta paṃca bhaven=mā
40^r F^1 naṃ
tattisth⟨ā⟩ne
39^r F^3 ⟨p⟩ra⟨māṇakaṃ /

1–3. *Example 1 for Sūtra C6.* 1. The third and the fourth rows on $38^v F^3$, and the fifth and the sixth rows on $39^v F^7$. The space right to the enclosure is left blank. 4–10. *Sūtra N14.* 11–21. *Example 1 for Sūtra N14.* 12. Part of 'pṛṣṭhā' on $39^r F^1$. 14. Part of 'lyā' on $40^r F^5$. 18. Part of 'pta paṃca bhaven=mā' on $40^r F^1$. 19–20. Part of 'naṃ tattisth⟨ā⟩ne' on $39^r F^3$. 20. tatti?bhaḍḍi?bhatti?

39^r F^1 5 paṃca⟩dhā sapta paṃcānāṃ
trdvimekaḥ=prakalpitaṃ /
tasya vāhasya kiṃ karma
mū⟨lyaṃ
6 ca ka⟩tthyatā mama /
kṣetrasya sthāpanaṃ kṛyate /
karaṇaṃ / kṣetra □.i ⟨□⟩
7 300 bhedaṃ da⟨tvā 150⟩
38^r F^2 8 vaipulyād=yogaṃ □⟨□□⟩
39^r F^8 9 eṣa ṣaṭkas(th)āne ⟨□□□⟩



1–10. *Example 1 for Sūtra N14.* 1. paṃcānāṃ > paṃcātha. 3. Part of 'kiṃ' on $39^r F^3$. 5. Part of 'tthyatā' on $38^r F^2$. 7–10. These statements are written to the right of the geometric figure. 8. Part of '300 bhedaṃ da' on $38^r F^2$. 9. Part of 'pulyād=yo' on $39^r F^6$. 10. Part of 'ṣa' of 'eṣa' on $38^r F^2$. *Figure.* Most of the extant parts of the figure appear on $38^r F^2$, only the tip of the highest corner being on $39^r F^1$.

V 6 (38#1^v)

40^v	F^1	1	⟨...⟩ □ (4) │ (...)
		2	⟨...⟩ □hartya caiva tat(kaṭ)ī □□
		3	⟨□□□⟩ guṇitā jātā │ 6210 │ eṣa vāhasya kāṇḍapramāṇaṃ
40^v	F^5	4	⟨tr⟩(airā)
40^v	F^1		śike mūlyaṃ kartavyaṃ / adhacchedaṃ catusaṣṭhibhi (bha
39^v	F^1	5	v)⟨eṭ=ṭa⟩llo / atha dvātriṃśabhi maṇḍalakai ṭallikā / eśa cchedaṃ bhava(t)i ⟨/⟩
		6	yathecchayā kāryā / atha ṭalakriyāudāharaṇaṃ ṭalasya ya⟨di
		7	mū⟩(lya)m=ekaṃ ta dvāśaṣṭhiśatānāṃ daśādhikānāṃ kiṃ mūlyaṃ
38^v	F^2		ḥ ṭalla⟨sya⟩
		8	⟨64 ma⟩ṇaleā ⟨1⟩ ‖ bhajābha 1 mūlye khasāga (1) ‖ 6210 maṇaleābhiṃ 1 ‖
			phala⟨ṃ
39^v	F^6	9	□□□⟩ □p. □□ya
39^v	F^8		di ⟨□□□⟩
38^v	F^2		□ṃ m⟨ū⟩l⟨y⟩eṇa ka k⟨r⟩īyate / □□□□□ṃ ⟨□⟩

1–17. *Example 1 for Sūtra N14.* 5. Part of 'cchedaṃ catusaṣṭhibhi' on $39^v F^1$. 6. Part of 'llo / atha dvātriṃśa' on $39^v F^3$. 10–11. Part of 'dvāśaṣṭhi... mūlyaṃ' on $38^v F^2$. 13. ma⟩ṇaleā ‖ bhajābha > ma⟩ṇaleābhi ‖ jātaṃ .

VI 1 (29^r)

⟨sūtraṃ //
icchāṅkaṃ prathame nyasya
tadādīn=śodhayet=kramāt /
icchāṅkaśeṣayogārdhaṃ
prathamadha
29^r F[5] 1 na⟩
(m)=ādiśet //
udā //
dhanā(ni) □□□□□
□□□□□⟨□□□/⟩
2 (ā)dyadvitīyayom=miśraṃ
dhanaṃ tatra ttrayodaṣaḥ
dvitīyatṛtīyayom=miś⟨ra⟩ṃ
⟨dhanaṃ tatra
3 catu⟩rdaśa /
ādyatṛtīyayom=miśraṃ
dhanaṃ paṃcadaśa smṛtaḥ
ekaikasya dha(na)⟨ṃ kiṃ syād=
ve⟩
4 cchi ce katthyatāṃ mamaḥ

13	14	15
1	1	1

⟨karaṇaṃ /
5 icchāṅkaṃ⟩
F[3] pratham⟨e⟩ ṇyasya / tatrecchā paṃcaḥ 5 tat=
prathama (ca) ⟨dhanaṃ / nyāsaḥ⟩
F[3,4] 6

⟨5⟩	⟨1⟩(3)	14	15
⟨1⟩	⟨1⟩	1	1

tadādīn=śodhayet=kramāt
ādimarāśī paṃ
F[3] ca ś⟨o⟩ddh⟨yaṃ
7 śeṣaṃ⟩ ⟨8⟩
F[4] eta caturdaśabhi śoddhya śeṣaṃ 6 etat=paṃca
⟨daśabhyaḥ śodhyaṃ
8 śeṣaṃ⟩ (...)

1–7. *Sūtra N15.* 8–32. *Example 1 for Sūtra N15.* 26. Enclosure up to the second cell lost. 29. Enclosure lost.

29^r F[1] 1 ⟨. . . ⟩ □dha prā⟨. . .
2 . . . ⟩ □□ṃ ca .i ⟨. . . ⟩
F[6] 1 d.ś.

VI 2 (29^v)

⟨udā //
1 □□□□□□□□
□□□□□□□□/
29^v F[5] ād⟩yadvitīyay⟨o⟩m=miśra⟨ṃ⟩
dhana⟨ṃ ṣo
2 ḍaśa tu smṛtaṃ /
dvi⟩tīyatṛtīyay⟨o⟩m=miśraṃ
dhanaṃ saptādaśa smṛtaḥ
tṛtīyaścaturthayo⟨ś=ca
3 miśraṃ dhanaṃ aṣ⟩(ṭ)⟨ā⟩(daśa) /
catuḥpaṃcakamiśraṃ tu
dhanaṃ ekonaviṃśati /
pra(thama)⟨ḫ⟩(pa)ṃ⟨camayo
4 m=miśraṃ
dhanaṃ⟩ (viṃ)śati tatra ca /
ekaikasya dhanaṃ kiṃ syād
vecchi ce gaṇa⟨kottama //⟩
29^v F[3,5] 5

⟨16⟩	17	18	19	20
⟨1⟩	⟨1⟩	1	1	1

F[3] karaṇaṃ // icchā⟨ṃ⟩(ka)⟨ḫ⟩=pra(tha)⟨me nyasya /
6 tatrecchā⟩ ⟨10⟩ tadānī śodhayet=kramāt=tatrādi 16 śu
F[3,4] ddhe śe(ṣa)ṃ ⟨6 dvitī
F[4] 7 yāyaṃ śodhyaḥ 11⟩ tṛtīyāyaṃ śoddhya 7 caturthāyaṃ śoddhya 12 paṃ⟨camāyaṃ
8 śodhyaḥ 8 □□□□□⟩ .i.i □□⟨. . . ⟩

29^v F[1] 1 (. . .)
F[6] 1 ⟨. . . ⟩ □□⟨. . .
2 . . . ⟩ □□ṃ □⟨. . . ⟩

4–28. *Example 2 for Sūtra N15*. 21. Enclosure up to the third cell lost. 23. Enclosure lost. tadānī > tadādīn.

VI 3 (27#^{v})

27^v 1 (. . .)

2 ⟨pratha⟩masya dhanaṃ / evaṃ anukrameṇa pūrv⟨o⟩ kt⟨ā⟩(n)⟨āṃ⟩ sthāpa⟨naṃ k⟩ṛ⟨yate / ⟩

3

(9) pra	7 dvi	10 tṛ	8 ca	11 paṃ
⟨7⟩ (dv)⟨i⟩	10 tṛ	8 ca	11 paṃ	9 pra

yutaṃ jātaṃ pratyaika⟨ṃ /⟩

4 16 / 17 / 18 / 19 / (2)⟨0 / e⟩vaṃ sarvatra kārayet //

29^v F^2

VI 4 (27#^{r})

27^r 1 ⟨. . . c⟩cha(ma) / tasmāt=ki⟨□□□□□// ⟩

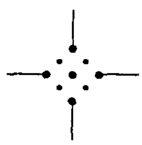
2 ⟨gu 4⟩ ‖ (gu 3) ‖

karaṇaṃ / pṛthak rūpaṃ vinikṣipyaḥ pṛthak rūpaṃ kṣiptaṃ jātaṃ (5)|⟨4⟩ ⟨guṇā⟩

3 bhyāso / tatra guṇa 3 | 4 abhyāsaṃ 12 rūpahīnaṃ 1⟨1⟩ ⟨rūpoṇā⟩

4 abh⟨y⟩āsā catuḥpaṃcakā / atra kṣiptaṃ jātaṃ 15 | 16 eśa tṛgu(ṇa)⟨caturgu

5 ṇo⟩ (jā)tā mūladhanāni catuḥpaṃca // 5 / 4 / eṣa ⟨. . . ⟩

29^r F^2 6 ⟨□□□□□□□⟩  //

sūtraṃ //

guṇau ⟨□□□□□

7 □□□□k. dhanaṃ //

guṇabhyāso rūpahīnaṃ labdhaṃ rūpaṃ ⟨□□□□//⟩

8 (. . .)

1–6. *Example 2 for Sūtra N15* . 4. Bottom line for the first cell lost. 6. Lower parts of 'vaṃ sarvatra kā' on 29^{v}F^2. 7. Three-line space on 29^{v}F^2 is left blank. 8–16. *Example 1 for Sūtra N16.* 8. ⟨. . . c⟩ About 18 *akṣaras* lost. 9. Bottom lines for the first cell lost. 11. Enclosure, except left side, lost. 13. Right half of enclosure lost. 16. ⟨. . . ⟩ About 6 *akṣaras* lost. 18–21. *Sūtra N17.*

VII 1 (65^v)

65^v 1 ⟨...
ta⟩tra (ki)⟨ṃ pada

2 m u⟩cyateṃ //

ā 1	u ⟨1⟩	⟨pa⟩ 0	(ga) 60
1	⟨1⟩	1	

karaṇa⟨ṃ /

3 a⟩ṣṭhottaraghne gaṇite / aṣṭhaghanaṃ 480 / uttaraghana⟨ṃ

4 ta⟩d=⟨e⟩va / dvighnam=ādi / ādi dviguṇa / 2 / cayojjhitaṃ ca

5 ⟨ya⟩ uttaraṃ / ato uttaraṃ pātayitvā ekaṃ bhavati / 1 / var(g)i⟨ta⟩ṃ

6 ⟨ta⟩tra nikṣipya dhanasya / 481 / mūlaṃ śliṣṭhakaraṇyaḥ

| 21 |
| 40 |
| 42 |

7 ⟨aṃśa⟩s=tv=aṃśaṃ | 882 / 40 / 42 | śeṣaṃ catvāriṃśa pṛthak=sthāpya

| 40 |

8 ⟨upare⟩ yojyaṃ | 922 / 42 | tanmūlavarjitaṃ // tanmūla / 1 ⟨/

9 varjitaṃ⟩ | ⟨880⟩ / ⟨42⟩ | ⟨dv⟩ig⟨u⟩ṇot⟨t⟩arasaṃbha⟨ktaṃ⟩ | 880 / (8)2 |

⟨eṣa

10 padaṃ // ... ⟩

1–17. *Example 1 for Sūtra N18.* 1. ⟨... About 17 *akṣaras* lost. 4. Enclosure between the middles of the second and the third cells lost. 6. The *akṣaras*, 'gha' and 'na', of the first 'ghanaṃ' are joined with a hyphen-like stroke. 15. The first enclosure and the left half of the second enclosure lost. (8)2 > (8)4. 17. Existence of the tenth line of writing is not certain.

VII 2 (56^v)

56^v 1 (. . .)

2

880	964	guṇitaṃ jātaṃ	848320	catvāriṅś⟨ānāṃ⟩
84	168		14112	

3 pṛthaksthānāṃ vargaṃ \\ 160⟨0⟩ /

4 ⟨e⟩ṣa uparā pātya śeṣaṃ \\ 846720 / 14112 / vartya jātaṃ \\ 60 /

5 //

56^v F[1] 1 ⟨. . .⟩ | ⟨. . .⟩ / 84 | ⟨. . .

2 . . .⟩ kṛyat⟨e . . .⟩

F[2] 1 □ghna □□r.y. □□

F[3] 1 | ⟨. . .⟩ / 8(4) |

VII 3 (56^r)

56^r F[1] 1 ⟨□□⟩ sti \\ da / ⟨. . . vargitaṃ ta

56^r 2 tra ni⟩kṣ(i)pya \\ 48⟨1⟩ / ⟨mūlaṃ ta⟩ | ⟨21⟩ / 20 / 21 | d=aśuddhaḥ

tasthāt

(a)⟨k⟩ṛ⟨teḥ śli⟩

3 ṣṭhakṛtyūnāt=śeṣacchedo dvisaṃguṇaṃ / tadvarga(dalasaṃ

śli)ṣṭhaḥ hṛti śuddhi kṛtikṣayaḥ //

śeṣacchedo dvisaṃguṇa kṛ⟨taṃ tadva⟩

5 rgaṃ

21					21 bhā
20	400	dala	1	saṃśliṣṭhaḥ	20
21	441		2		21 +

śeṣaṃ pātya (aṃ)⟨śas=tv=aṃśaṃ

6 kṛ⟩tvā bhājita | ⟨21⟩ / ⟨461⟩ | ⟨a

1–5. *Example 1 for Sūtra N18.* 3. Right half of enclosure lost. 5. The lower half of the page is left blank. 6. Upper half of enclosure lost. 9. Enclosure mostly lost, only the bottom-left corner being preserved. 10–20. 2nd solution of *Example 1 for Sūtra N18.* 10. ⟨. . . About 13 *akṣaras* lost. 11. Part of 'kṣ(i)pya \\ 48⟨1⟩ /' on 56^r F[1]. Right half of the first enclosure lost. The first row of the second enclosure lost. 20. Enclosure lost.

56^r 7 dhe⟩ (a)dhaṃ upare uparaṃ guṇitavyaṃ vargaṃ yāva varjaye⟨t=tatra sadṛ

8 śaṃ kṛta⟩ṃ

425042	400 +
⟨19362⟩	193⟨62⟩

śeṣaṃ

4246(4)⟨2⟩
⟨1⟩93⟨62⟩

9 (...)

56^r F^2 1 katidina⟨□⟩re □

F^3 1 ———

VII 4 (64^r)

64^r 1 (...)

2

⟨40⟩5280	444004
⟨3⟩8724	38724

t.y.rdhe □tu s. ⟨□□□□□⟩

3 ardhaṃ kartavyaṃḥ tasya ⟨sthāpanaṃ⟩

4

⟨40⟩5280	444004
⟨3⟩8724	77448

saṃguṇya jātaṃ / aṃ⟨śān=aṃśeṣu⟩

5 hrarā hareṣu gu(ṇa)⟨yet □□□⟩

6

⟨1⟩79945941120
2999096352

asya ūrdhāṃka⟨taḥ śe⟩

7 ṣa jātaṃ (para)⟨□□□

8 □□□□□□□⟩ | 160000 + | □□⟨□□□□□⟩

VII 5 (64^v)

64^v 1 ⟨□□□□□□□□⟩ □(va)⟨r⟩gita⟨ṃ⟩ 1 tatra ⟨nikṣipya 41 mūlaṃ /

2 śe⟩ṣacchedo dvisa⟨ṃ⟩guṇaṃ

6
5
12

śeṣaṃ paṃcakaṃ pṛtha(k=sth)⟨āpya⟩

3 aṅśas=tv=aṃśaṃ

77
12

tanmūlavarjitaṃ / tanmūla 1 p⟨ātyaṃ⟩

4

⟨6⟩5
⟨1⟩2

dviguṇottarasaṃbhaktaṃ

65
24

eṣa padaṃ //

1–4. 2nd solution of *Example 1 for Sūtra N18*. 3. Lower half of the first enclosure lost. Bottom line and right side of the second enclosure lost. 6. Part of an enclosure. 7–14. 2nd solution of *Example 1 for Sūtra N18*. 12. Left half of bottom line of enclosure lost. 14. Bottom line of enclosure lost. 15–21. *Example 2 for Sūtra N18*. 21. Left half of the first enclosure lost.

64^{v} ⟨pra
5 tyā⟩nayanaṃ ‖ ā 1 / 1 ‖ u 1 / 1 ‖ pa 65 / 24 ‖ rūpoṇā (41 / 24)
u⟨tta
6 raguṇ⟩(itā)ḥ dalitā (41 / ⟨48⟩) ādisaṃy⟨utā⟩ (⟨89⟩ / ⟨48⟩)
⟨padaghnā⟩
7 (⟨5785⟩ / ⟨1152⟩) ⟨. . .⟩

VII 6 (57^{v})

57^{v} 1 (. . .) ⟨a⟩
2 ṣṭh⟨o⟩ttaraghne gaṇite 40 dvighnam=ādi cayo⟨jjhitaṃ / vargitaṃ ta
3 t⟩ra nikṣipya 41 mūlaṃ (6 / 5 / 6) śeṣacchedo dvisaṃ
gu⟨ṇaṃ / kṛtaṃ tad=a⟩
4 śuddhaḥ tasnāt

akṛte śliṣṭakṛtyūnā śeṣacchedo dvi⟨saṃguṇaṃ / ta⟩

5 dvargadalasaṃśliṣṭa hṛti śuddhi kṛtikṣayaḥ

akṛte śliṣṭa⟨k⟩ṛ⟨tyūnāc=cheṣa
6 cch⟩edo dvisaṃguṇa kṛta (6 / 5 / 12) tadvarga

6				
5	25	dala	1	saṃ⟨śliṣṭa⟩
12	144		2	

7 | ⟨6 bhā⟩ / ⟨5⟩ / ⟨12 +⟩ | ⟨bhāga⟩ṃ ⟨hṛta⟩ṃ tu jātaṃ | 12 / ⟨77⟩ |

1–6. *Example 2 for Sūtra N18.* 4. Lower half of the first enclosure lost. The second enclosure lost. 6. Existence of the seventh line of writing is not certain. 7–19. 2nd solution of *Example 2 for Sūtra N18.* 10. 6 / 5 / 6 > 6 / 5 / 12. 13–15. *Sūtra Q2.* 18. Bottom line lost. 19. The first enclosure lost. Bttom line of the second enclosure lost.

VII 7 (57^r)

57^r 1 ⟨...⟩ ‖ ⟨6⟩ / 770 ⟨25 +⟩ / 1848 184(8) ‖ ⟨śeṣaṃ⟩

2 | ⟨6⟩ / ⟨74⟩5 / ⟨184⟩8 | (a)⟨ṃ⟩śa⟨s⟩=tv=a⟨ṃ⟩śa⟨ṃ⟩ | 11833 / 1848 | hṛ⟨ti

śuddhi⟩

3 kṛtikṣaya kṛtaṃḥ eśa mūlaṃ // tanmūla⟨varjitaṃ /

4 ta⟩nmūlaṃ ekaṃ 1 eṣa sadṛśe pāteta jāta | 9985 / 1848 | ⟨dvigu

5 ṇotta⟩rasaṃbhaktaṃ uttaraṃ dviguṇaṃ 2 anena bha ⟨ktaṃ jā

6 taṃ⟩ | ⟨9⟩985 / ⟨3⟩(6)96 | eṣa paṃcakasya padaṃ // // asya

pra(ty)⟨ānaya

7 naṃ //⟩

sūtraṃ //

eko rāśi dvidhā sthāpya rūpam=ekā⟨□□□□/⟩

8 (...)

VII 8 (45^r)

45^r 1 (...) ⟨rūpoṇā⟩ | ⟨10225⟩ / ⟨49200⟩ | ⟨uttaraghnā⟩

2 | ⟨10⟩225 / 32800 | dalitā | 10225 / 65600 |

3 ⟨ā⟩diyutaḥ | 108625 / 65600 | padaghnā pa⟨da

4 guṇi⟩tā ‖ 6455040625 / 3227520000 ‖ ato paṃcaviṅ⟨ś⟩ān⟨āṃ va

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1–13. 2nd solution of *Example 2 for Sūtra N18.* 1. Upper half of enclosure lost. 2. Left side and bottom line of the first enclosure lost. 5. Right side of enclosure lost. 8. Left half of enclosure lost. 11–13. *Sūtra Q9.* 14–17. *Example 3 for Sūtra N18.* 14. Enclosure lost. 15. Left side of the first enclosure lost.

45ʳ 5 rgaṃ⟩ pāti$_{ta}$ uparāḥ tapada ‖ 6455040⟨000⟩ / 3227520⟨000⟩

6 ⟨bhāge⟩ hṛte labdhaṃ 2 eṣa dhanaṃ // //

7 ⟨a⟩nyam

ā 1	u 1	padu 0	dhanu 7000
1	1	1	1
2	2		

aṣṭotta ⟨raghne gaṇite

8 dvighnam⟩=ādi ⟨cay⟩o⟨jjh⟩i⟨taṃ vargitaṃ ta

9 tra nikṣipya⟩ ⟨33600⟩9 / ⟨4⟩ (mūla)ṃ caturṇāṃ jā(ta 2)

⟨. . .⟩

VII 9 (45ᵛ)

45ᵛ 1 ⟨□□□□⟩ 7⟨68⟩ (a)⟨s⟩y⟨ārdhaṃ⟩ 384 asya varga 147456 asya va⟨rga⟩

2 ⟨217⟩43271936 eṣasarva guṇitā karaṇi pāti⟨ta

3 aṃśas=tv=aṃ⟩(śa)ṃ kṛtvā bhājita jātaḥ 1158 + / 671250 aṃśair=aṃśā guṇayet=(ta)

4 ⟨tra ca cche⟩(dā)⟨ṃ⟩śāni vartya jātaḥ

579	
768	29491⟨2 +⟩
1158	777307500

5 ⟨savarṇitaṃ⟩

579	
515520000	294912 +
777307500	777307500

6 ⟨pātayitvā⟩ śeṣaṃ ‖ 579 / 51522508⟨8⟩ / ⟨77730⟩750⟨0⟩

7 ⟨aṃśas=tv=aṃ⟩śaṃ

8 ⟨kṛtaṃ jātaṃ⟩ ‖ ⟨4505762⟩67588 / ⟨777307500⟩ ‖ dvayena mūle

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1–2. *Example 3 for Sūtra N18.* 1. Bottom lines, below '⟨000⟩', of enclosure lost. 3–18. *Example 4 for Sūtra N18.* 6. Left side and bottom line of enclosure lost. 8. Right half of the first enclosure lost. 10. Bottom line, below '⟨217⟩', of enclosure lost. 16. Lower half of enclosure lost. 18. Enclosure lost.

45v 9 ⟨na hṛtaṃ⟩ ‖ ⟨450576267588⟩ / ⟨1554615000⟩ ‖ ⟨e⟩(tan=m)⟨ūla⟩ṃ ⟨. . .⟩

VII 10 (46r)

46r 1 ⟨padaṃ⟩ | ⟨448244345088⟩ / 4663845⟨000⟩ | ⟨rūpoṇā⟩

2 | ⟨443580500088⟩ / 4663845000 | ⟨uttaraghnā⟩

3 ⟨2⟩21790250044 / ⟨1⟩554615000 ‖ dalitā e⟨va⟩

4 ‖ 110895125022 / 1554615000 ‖ ādisaṃyut⟨ā⟩

5 ⟨11⟩3227047522 / ⟨1⟩554615000 ‖ padaghnā kā⟨ryā⟩

6 ‖ 50753383762746743271⟨1936⟩ / 7250483394675000⟨00⟩

7 ⟨asya u⟩parā karaṇipāta

8 21743271936 pātita jātā uparā nyāsasthāpa⟨naṃ⟩

9 ⟨507533837627⟩25000000000 / ⟨7250483394675000000⟩ ‖ bhāge ⟨hṛte labdhaṃ

10 7000 etad=dhanaṃ /⟩

VII 11 (46v)

46v 1 □(puru)⟨□□⟩ / maṇḍakā 20 | ⟨□⟩ □

| ⟨. . .⟩ / ma⟨ṃ⟩ḍe 8 ‖ ⟨□⟩ □□ / maḍe 6 ‖ □□⟨□⟩ / maṃḍe (8) ‖

2 □aparaprastaḥ
pārāāie vīhu jaṇa vīhārhai s(sa)⟨□□⟩

3 paṇa /
gore jāma catuppaṇe sāmalea (ad)dhapa(ṇ)i ⟨□□⟩

1–11. *Example 4 for Sūtra N18.* 1. Enclosure lost. 2. Upper half of enclosure lost. 3. Upper half of enclosure lost. 4. Bottom lines, below '⟨1⟩,' of enclosure lost. 6. Bottom lines, below '⟨1⟩,' of enclosure lost. 7. Bottom lines, below '⟨00⟩,' of enclosure lost. 10. Enclosure lost. 12–13. *Example 1 for Sūtra C7.* 13. Right side of enclosure lost. 14–17. *Example 2 for Sūtra C7.*

46^{v} 4 □ḍha le ā po ttī le ā ga ṇe vīhu jaṇa ehu vīhu □⟨□□⟩
5 karaṇaṃ / traigore vārahahi paṇehi sāḍhe (sa) ⟨□□
6 □□⟩(paṇ)ehi / (tra)ï sūḍha cahiyo .i □.i ⟨. . . ⟩

VII 12 (58^{v})

58^{v} 1 ⟨□□□⟩ □(ś). □p. (ś).m.t.p.(t //) sthāpanaṃ kṛya(te)
2

⟨manu⟩ṣya 1	yuvī 1	sūḍha 1	dṛṣya 20 ja(na)
1	1	1	
⟨ma⟩ṃḍa 3	maṃ 1	maṃḍa 1	maṃḍe 2⟨0 □□⟩
1	1	2	
	2		

3 ⟨□□□⟩ □ta datta jātaṃ maḍa 2 / yuvī 5 /
sūḍhe 1(3) ⟨/
4 □□□□⟩ □⟨□□⟩ □⟨□⟩ maṃḍe □□□□⟨□⟩ □⟨. . . ⟩

VII 13 (56^{r})

56^{r} 1 (. . .)
2 (u)dā //
śaḍviṃśaś=ca tṛpaṃcāśa ek⟨o⟩natṛ⟨ṃ⟩meva ca /
dvāśa⟨ṣṭiś=cai
3 va⟩ śaḍviṃśa catuścatvāliṃśa saptati /
catuṣṣaṣṭhi nava⟨navati
4 r=dvācat⟩v⟨āl⟩iṃśa naṃtaraṃ /
tṛrāśīti ekaviṃśa aṣṭhā⟨daśa
5 ca sa⟩p(ta)kaṃ /
6 ⟨265⟩(3)296226447064994⟨283
7 21187 // □□□□□⟩ □eśa □⟨□⟩ .i ⟨. . . ⟩

1–3. *Example 2 for Sūtra C7.* 4–8. *Example 3 for Sūtra C7.* 6. maḍa > manu. 9–19. *Example 1 for Sūtra C8.* 10. tṛ⟨ṃ⟩meva > tṛ⟨ṃ⟩śam=eva. 15. ṛdvā?stri?ṣṣaṭ? 16. daśa?viṃśa?tṛṃśa?ṣaṣṭi?śīti?

VIII 1 (59^v)

Blank

VIII 2 (59^r)

59^r 1 (. . .)

2 ⟨□□⟩ // udā //

ko rāśi paṃcayutā ⟨m⟩ūla⟨da⟩ḥ sā rāśis=saptah⟨īnaḥ /⟩

3 mūlada ko so rāśir=iti praṣṭaḥ

0	5 yu	mū 0	sā 0	7 +	mū 0
1	1	1	1	1	

(ka)⟨ra⟩

4 ṇaṃ / yutahīnaṃ ca m=ekatvaṃ 12 ta⟨sya da⟩

5 laṃ 6 dvihrīṇaṃ 4 dalaṃ 2 vargaṃ 4 hīne yutiṃ ca kartavyā / ⟨hī

6 n⟩e 7 + anena yuti 11 eṣa sā rāśi // asya pratyānayane ny⟨āsaḥ⟩

7

11	yu 5	mū 4	11	7 +	mū 2
1	1	1	1	1	1

paṃcāśamasūtraṃ 50 ⟨ ⟩

8 // sūtraṃ

gavāṃ viśeṣa kartavyaṃ dhanaṃ caiva punaḥ=⟨ku⟩ruḥ

⟨□□□⟩

9 (. . .)

VIII 3 (60^r)

60^r 1 ⟨□□□□⟩ □□□□□

⟨gāvī □□⟩	⟨rūpa □□⟩	(rdhepha)
gāvī 10 1	rūpa 8 1	

2–12. *Example 1 for Sūtra 50.* 13. Ending mark lost. 14–17. *Sūtra 51.* 18–19. *Example 1 for Sūtra 51.* 19. Upper half and right side of enclosure lost (the line above 'rūpa 8' visible).

60ʳ 2 ⟨e⟩ṣa ekonaviṃśatima
3 ⟨patre⟩ vivaritāsti //

4 ⟨ekapaṃ⟩cāśamasūtraṃ 51 //

sūtraṃ //
āyavyayaviśeṣaṃ tu
vibha
5 ⟨ktaṃ⟩ driṣyasaṃguṇaṃ /
yal=labdhaṃ sā bhavet=kālaṃ
ayaṃ praṣṭe
6 ⟨vya⟩ye vidhi //
udā //
dvidine ārjaye paṃca tṛdine nava (bhakṣay)e(t)
7 (bh)āṇḍāgāraṃ tasya tṛṅśa kiṃ kālaṃ ārjabhakṣaṇaṃ

dī 5	dīnāraṃ 9	dṛ
di 2	dina 3	30

8 ⟨kara⟩ṇaṃ / āyavyayaviśeṣan=tu / tatrāyaṃ $\frac{5}{2}$

9 ⟨vyayaṃ⟩ $\frac{\langle 9\rangle}{\langle 3\rangle}$ ⟨vartyaṃ⟩ $\frac{\langle 3\rangle}{\langle 1\rangle}$ ⟨anayor=v⟩i⟨ś⟩e⟨ṣa⟩ṃ

⟨kṛtvā⟩ $\frac{\langle 1\rangle}{\langle 2\rangle}$ ⟨vibhaktaṃ⟩ $\frac{\langle 2\rangle}{\langle 1\rangle}$

10 ⟨dṛśyasaṃguṇaṃ / dṛśyaṃ⟩ ⟨30⟩ ⟨anena guṇitaṃ jātaṃ⟩
⟨60⟩ ⟨etatkālena
11 ārjanabhakṣaṇaṃ //⟩

VIII 4 (60ᵛ)

60ᵛ 1 ⟨□□□□pratyayas=trairāśikena⟩

⟨2⟩	⟨5⟩	⟨60 di⟩	⟨phalaṃ 150 dī⟩ 1
⟨3⟩	⟨9⟩	60 di	phalaṃ 180 ⟨dī⟩ 1

2 ⟨□□⟩ □□□□□□□□□//

1–2. *Example 1 for Sūtra 51*. 4–10. *Sūtra 52*. 11–23. *Example 1 for Sūtra 52*. 14. Bottom lines for the third cell lost. 16–19. Enclosures lost. 18–20. Existence of these lines of writing not certain. 22. Upper half of enclosure, and right half of the fourth cell in the lower row, lost.

60^{v} 3 dvāpa⟨ṃ⟩cāśamasūtraṃ 52 //

4 // sūtraṃ
ahadravya harāśau tatadviśeṣaṃ vi(bh)⟨ājitaṃ /⟩
5 yal=labdha dviguṇaṃ kālaṃ dattā samadhanā prati //
u⟨dā //⟩
6 tṛdine ārjaye paṃca bhṛtako m=eka paṇḍitaḥ
dvitīyaṃ paṃca⟨d⟩i
7 vase rasam=ārjayate budhaḥ
prathamena dvitīyasya sapta dattā (h)i ⟨rū⟩
8 (pakā)ḥ
datvā samadhanā jātā kena kālena katthyatāṃ

5 rū	6 ⟨rū⟩	⟨dattaṃ⟩
⟨3 di⟩	⟨5 di⟩	⟨7⟩

9 ⟨karaṇa⟩ṃ ⟨/ ahadravya⟩ṃ ⟨ha⟩(rā)ṃśau ta⟨ttadviśeṣa⟩ṃ ⟨vibhājitaṃ / □□□⟩

VIII 5 (61^{r})

⟨vi
61^{r} F 1 bhājitaṃ⟩ ⟨15⟩ 7 ⟨dattaṃ⟩ ⟨7⟩ ⟨dviguṇaṃ⟩ ⟨14⟩

⟨guṇitaṃ⟩	⟨15⟩	⟨14⟩	⟨jātaṃ⟩
	⟨7⟩	⟨1⟩	

61^{r} 2 ⟨30⟩ ⟨1⟩ anena kālena samadhanā bhavanti // pratyay⟨e⟩
tr(ai)rāśika⟨ṃ k⟩ṛ⟨taṃ⟩

3

3	5	30	pha 50	prathame dvitīyasya ssapta
⟨1⟩	1	1		
⟨5⟩	6	30	36	
⟨1⟩	1			

dattā / 7 śeṣaṃ 43 /
4 4(3) / 43 ete samadhanā jātā //

-4. *Sūtra 53.* 5–22. *Example 1 for Sūtra 53.* 12. Enclosure mostly lost, only upper half for the first cell being eserved. 16. Upper half of the first enclosure lost. The second and the third enclosures lost. 17. Enclosure st. 18. Left half of enclosure lost. 'e' of 'kālena' on 61^{r}F. 20. Bottom lines for the first cells in both rows lost. :. Delete '4(3).'

61ʳ udā //

5 ⟨rā⟩japutro dvayo keci nṛpatissevya santi vaiḥ

m=ekāsyāhne dvayaṣ=ṣa

6 ⟨ḍ⟩gā / dvitīyasya divardhakaṃ /

prathamena dvitīyasya daśadīnāra

7 ⟨da⟩ttavān

kena kālena samatāṃ gaṇayitvā vadāśu me //

8

⟨13⟩	3	dattaṃ 10
⟨6⟩	⟨2⟩	1

karaṇaṃ // ahadravyaviśeṣaṃ ca / tatra ⟨e

9 kasyāhadravyaṃ⟩ | ⟨13⟩ ⟨6⟩ | ⟨dvitīyasya⟩ | 3 ⟨2⟩ | □□□□□

□.e □□ṃ ⟨□□⟩

VIII 6 (61ᵛ)

61ᵛ F 1 (. . .) ⟨pratya

2 yas=trairā⟩

61ᵛ śik⟨e⟩na /

1	13	30	pha 65
1	6	1	
1	3	30	pha 45
1	2	1	

prathamena dvitīya

⟨sya daśa⟩

3 n=dattā jātā / 55 / 55 // samadhanā jātā

4 sūtraṃ tṛpaṃcāśamaḥ sūtraṃ 53 //

⟨v⟩i⟨kra⟩

5 yena krayaṃ bhājyaṃ rūpahīnaṃ punar=bhajet

lābhe⟨na⟩

6 guṇaye tatra nīvī bhavati tatra ca //

1–16. *Example 2 for Sūtra 53*. 3. 'sa' is written below 'yaṣ=ṣa.' 8. Lower half of enclosure for the first two cells lost. 10. The first enclosure and lower half of the second enclosure lost. 14. Bottom line for the fourth cell of the first row of enclosure lost. Part of 'prathamena dvitīya' on 61ᵛF. 17. The first 'sūtraṃ' should come after the ending mark. 18–21. *Sūtra 54*.

61v udā //
dvibhiḫ=kṛṇāti ya⟨s=sa⟩
7 pta vikṛṇāti tṛbhiṣ=ṣaṭ
aṣṭhādaśa bhave r=lābhāḫ=kā nī⟨vī
8 ta⟩tra katthyatāṃ //

7	6	18 lābhā
2	3	1

karaṇaṃ / vi⟨krayena
9 krayaṃ bhājya⟩ṃ ⟨/ tatra krayaṃ⟩ $\frac{\langle 7\rangle}{\langle 2\rangle}$ ⟨vikrayaṃ⟩ $\frac{\langle 6\rangle}{\langle 3\rangle}$
⟨vartyaṃ⟩ $\frac{\langle 2\rangle}{\langle 1\rangle}$ ⟨anena⟩

VIII 7 (62r)

⟨bhaktaṃ⟩ $\frac{\langle 7\rangle}{\langle 4\rangle}$ ⟨rūpahīnaṃ jātaṃ⟩ $\frac{\langle 3\rangle}{\langle 4\rangle}$ ⟨punar=
bhaktaṃ⟩ $\frac{\langle 4\rangle}{\langle 3\rangle}$ ⟨lābhaḥ⟩ $\frac{\langle 18\rangle}{\langle 1\rangle}$
62r 1 ⟨ane⟩(na) guṇita⟨ṃ⟩ jāta⟨ṃ⟩ // 24 // eṣa nīvī jātā / sya pratya⟨yas=trairā
2 śi⟩k⟨e⟩na // yadi dvibhis=sapta labhyate / tadā caturviṃśatibhiḫ=kiṃ

2	7	(24)
1	1	1

3 ⟨pha⟩laṃ rū 84 // asya vikrayaṃ kṛyate / yadi ṣṣaḍbhi traya
4 ḫ=pa⟩ṇā labhyate tadā caturāśītibhiḫ=kiṃ

6	3	84
1	1	1

phalaṃ 42 //
5 (mū)laṃ 24 / pātya śeṣaṃ 18 eśa lābhāḥ

caupaṃcāśamasūtraṃ 54

1–20. *Example 1 for Sūtra 54*. 3. tṛbhiṣ > tṛbhis tu. 6. Bottom lines of enclosure mostly lost. 8–11. Restored.

62^r 6 vikrayaṃ bhājaye caiva guṇayet=krayapiṇḍatāṃ /
rū
7 ⟨p⟩oṇe mūla guṇaye labdha lābhaṃ ca prāpyate //
udā //
8 ⟨dvi⟩bhi krīṇāti yas=sapta vikṛṇāti tribhiṣ=ṣaṭ
mūlā catu(rviṃ)
9 ⟨śatiḥ syāt ko lābhas=tatra kathyat⟩ām

7	6	⟨24 mūlaṃ⟩
⟨2⟩	⟨3⟩	⟨1⟩

⟨karaṇaṃ /
10 vikrayaṃ⟩ ⟨6⟩/⟨3⟩ ⟨bhaktaṃ⟩ ⟨3⟩/⟨6⟩ ⟨krayaṃ⟩ ⟨7⟩/⟨2⟩
⟨anena⟩

VIII 8 (62^v)

⟨guṇitaṃ⟩ ⟨21⟩/⟨12⟩ ⟨rūpoṇaṃ jātaṃ⟩ ⟨9⟩/⟨12⟩ ⟨mūlaṃ⟩
⟨24⟩/⟨1⟩ ⟨anena guṇitaṃ jātaṃ⟩ ⟨18⟩/⟨1⟩ ⟨eṣa lābhaḥ //
pratyayas=trairāśi

62^v 1 kena⟩

(2)	7	24	pha 84
1	1	1	1

atha vikraya⟨ṃ⟩

6	3	84	pha 4⟨2⟩
1	1	1	1

⟨mū
2 laṃ⟩ 24 / pātya śeṣaṃ 18 / eṣa lābhaṃ //

paṃcapaṃcāśamasūtraṃ (55 ✣)

3 vikrayaṃ bhājaye caiva guṇayet=krayapiṇḍavat
vibhaktaṃ
4 sa ca kartavyaṃ guṇaye miśrakaṃ budhaḥ
yal=labdhaṃ sā bhaven=mū⟨laṃ⟩
5 ya śśeṣaṃ lābhapiṇḍatāṃ //

1–3. *Sūtra 55.* 4–17. *Example 1 for Sūtra 55.* 5. tṛbhiṣ > tṛbhis tu. 8. Enclosure mostly lost, only upper half of left side being preserved. 10–14. Restored. 16. Bottom line below '⟨2⟩' and right side of enclosure lost. 19–23. *Sūtra 56.*

62ᵛ udā //

trbhiś=ca labhate n=aṣṭhau catu⟨rbhi⟩

6 (r=vi)kraye ṣṣaṭ

samūlalābham=utpaṇṇā śataṃ śaṣṭivimiśṛtaṃ /

⟨kiṃ mū⟩

7 (la)ṃ kaś=ca lābhaṃ ca kathayed=gaṇakottamaḥ

8	6	miśra 160
3	4	1

ka⟨ra

8 ṇaṃ /⟩ (vi)krayaṃ bhājaye caiva g⟨u⟩ṇaye⟨t=kraya

9 piṇḍavat / tatra vikrayaṃ⟩ (⟨6⟩ / ⟨4⟩) ⟨bhājitaṃ⟩ (⟨4⟩ / ⟨6⟩)

⟨krayaṃ⟩ (⟨8⟩ / ⟨3⟩)

VIII 9 (63ʳ)

⟨anena guṇitaṃ⟩ (⟨32⟩ / ⟨18⟩) ⟨vibhaktaṃ⟩ (⟨18⟩ / ⟨32⟩) ⟨miśraṃ⟩

(⟨160⟩ / ⟨1⟩) ⟨anena guṇitaṃ⟩ (⟨90⟩ / ⟨1⟩) ⟨etan=mūlaṃ jātaṃ /

pātya śeṣaṃ⟩

63ʳ 1 (⟨70⟩ / ⟨1⟩) ⟨eṣa lābhaḥ // pra⟩tya(yaḥ)

⟨3⟩	⟨8⟩	⟨90⟩	⟨phalaṃ 240⟩	⟨vikra
1	⟨1⟩	⟨1⟩	⟨1⟩	

2 ye⟩ pratyayaḥ

6	4	240	phalaṃ 160
1	1	1	1

mūlaṃ (90)

pātya śeṣa⟨ṃ⟩ (7⟨0⟩)

3 ⟨ṣa⟩tpa⟨ṃ⟩cāśamasūtraṃ 56 —⁘— //

1–18. *Example 1 for Sūtra 56.* 3. ṣṣaṭ > tu ṣaṭ. 7. Bottom lines for the first two cells lost. 10–14. Restored. 16. Enclosure mostly lost, only the bottom line being preserved.

63ʳ vikrayaṃ ca vibhaktavyaṃ guṇitaṃ kra
4 ⟨yar⟩āśivat
kṛtvā rūpakṣayaṃ caiva vibhaktaṃ mūlam=⟨ā
5 di⟩sāt //
udā //
paṃcabhiś=catuvargaṃ tu gṛhītaṃ kena mānake
6 ⟨rū⟩pakena ṣṣaṭ vikrītaṃ ṣṣaṭpaṃcāśa ṛṇaṃ kṛtaṃ /
krayavikraya saṃ
7 ⟨va⟩rtya nīvis=tasyaiva katthyatāṃ

16	6	riṇaṃ 56 +
5	1	1

⟨karaṇaṃ /
8 vikra⟩yaṃ bhājaye caiva (1/6) ⟨krayaṃ⟩

VIII 10 (63ᵛ)

(⟨16⟩/⟨5⟩) ⟨anena guṇitaṃ⟩ (⟨16⟩/⟨30⟩) ⟨kṛtvā rūpakṣayaṃ caiva⟩
(⟨14⟩/⟨30⟩) ⟨vibhaktaṃ⟩ (⟨30⟩/⟨14⟩) ⟨ṛṇaṃ⟩ (⟨56⟩/⟨1⟩) ⟨anena guṇitaṃ
jātaṃ⟩ (⟨120⟩/⟨1⟩) ⟨etan=mūlaṃ jātaṃ // pratyayas=
trairāśikena /⟩

⟨5⟩	⟨16⟩	⟨120⟩
⟨1⟩	⟨1⟩	⟨1⟩

63ᵛ 1 ⟨phalaṃ⟩ 384 // athāsya vikrayaṃ //

6	1	384
1	1	

phala⟨ṃ⟩ (6⟨4⟩)
2 mūla (120) catuṣṣaṣṭhi⟨p⟩ātya śeṣaṃ (56) eṣa riṇaṃ
kṛ⟨taṃ //⟩

3 (sa)ptapaṃcāśamasūtraṃ 57 //

1–4. *Sūtra 57.* 5–20. *Example 1 for Sūtra 57.* 12. Bottom line of enclosure lost. 13–16. Restored. 18. Right half of enclosure lost.

63^{v} vastraśulkaṃ yad=bhavati ta⟨da
4 pa⟩hṛtavastrato /
trairāśikavidhānena śulka⟨m=ā
5 na⟩ya tatvataḥ //
udā //
paṭasya śulka viṃśāṅśaṃ
kaś⟨c⟩i⟨d=dvā
6 catvā⟩riṃśataṃ /
paṭakānāṃ paṇa kṝte
dvau paṭau hṛta śaul⟨k⟩i⟨kau /
7 □□□□⟩ to ⟨□□□
para⟩ṃ paṇa daśas=tathāḥ
kiṃ mūlyaṃ ⟨vada
8 paṇḍita //⟩

1–4. *Sūtra 58.* 5–14. *Example 1 for Sūtra 58.*

IX 1 (44^v)

44^v 1 (. . .)

2 ⟨□□□⟩

44^v F[1] / bh⟨ā⟩(ṇḍāḥ sa)

44^v pta śatānāṃ kaḥ=
kālaṃ ārjanabhakṣaṇe //
nyāsasthāpanaṃ kṛya⟨te /⟩

3 ⟨ā 1 d⟩i ⟨1⟩ (bh)ā bha 8 di 5 bhā 1 pa 32 bhā

⟨ā 1	d⟩i ⟨1⟩	(bh)ā	bha 8	di 5	bhā 1	pa 32	bhā
⟨1⟩	⟨1⟩		1	1	1	1	
⟨2⟩	⟨3⟩			3			

śū 2 36 bhā	1 1
1 1 1	1 360
4 4	

4 ⟨vyaya⟩rāśi | 223 / 144 | āyarāśi | 280 / 61 | etatkālena ārjana
bha⟨k⟩ṣa⟨ṇaṃ //⟩

5

di 1	223	280	ūrdhacchedaṃ 36⟨0 /⟩
1	144	61	

6 phalaṃ vajja⟨ra

7 kā⟩n⟨i⟩ 2559 śe $\frac{1}{61}$ // eṣa vyaye //

8 ⟨kāle⟩ va 4 mā (7) di 2 śe ($\frac{28}{61}$) atha āya

di 1	1	28⟨0⟩	⟨ūrdha
1	1	⟨61⟩	
(3)	(2)		

9 cchedaṃ 360 / phalaṃ⟩ | ⟨1859⟩ / ⟨1⟩ / ⟨61⟩ | ⟨bhāṇḍāreṇa

sahāyapiṇḍaṃ⟩ | ⟨2559⟩ / ⟨1⟩ / ⟨61⟩ |

44^v F[2] 1 □□5

1–17. *Example 1 for Sūtra C9.* 7. 'i' of 'd⟩i' on $44^v F^1$. 9. After 'āyarāśi,' probably [9 / 8] and a passage leading to the answer, '$\frac{280}{61}$,' are missing. 13. A large knot after 'vyaye //.' 14. Bottom line of enclosure lost. 15. Bottom lines and right side of enclosure lost. 16–17. Restored. 18. 5?pa?

IX 2 (44^r)

44^r F^1 1 ⟨...⟩

⟨280⟩
⟨61⟩

44^r 2

⟨2⟩559	di 1
1	1
61	

⟨chedaṃ 360⟩

223
144

eṣā

3 vyayapramāṇaṃ // u⟨dā // daśakaṃ⟩

4 sārdham=utpati satṛbhāgadinadvayet pūjārthaṃ satṛbhāgaṃ ca tra⟨yodaśa⟩

5 (hi)tāś=cayet sāṣṭabhāgadinātrīṇi vāsudevasya cārcare /

6 pādonatrayodaśānāṃ ca aṣṭasārdhadināni vait //

7 brāhmaṇā bhojane dadyā paralokahitārthinaḥ satṛbhāgaṃ

8 (ca) vajjaraṃ sapaṃcabhāgadinattrayet pa⟨t⟩ra

9 ⟨□□⟩la c⟨ch⟩eśaṃ ca ka(ṇḍo)laven⟨u⟩va(ll)ikam= ardhaṃ sārdhaṃdine

10 ⟨na ca ...⟩

44^r F^1 1

	□

F^2 1 □va □|□

1–3. *Example 1 for Sūtra C9*. 1. Both sides of enclosure lost (only bottom lines visible). 4–25. *Example 2 for Sūtra C9*. 18. A large knot after '(ca).' 26. Fragmentary enclosure.

IX 3 (43^r)

43^r 1 ⟨□⟩ (sa) dhārayet
sārdhadvā(daśa) m=eva tu
bhojane madyam=uttamet
2 satṛbhāgatrayantṛṃśai
dinai d=vāṇijyakasya tu /
bhāṇḍāre dvāda
3 śa śata
vajarāṇāṃ sthitāsya vai /
eṣā vyaya samutpattau
kaḥ=kālaṃ brū
4 hi paṇḍita
karaṇavidhānena dvādaśaśata sya bhāṇḍāre sthitā
5

10	2	bhā	13	3	bhā	13	8	bhā	1	3 bhā
1	1		1	1		1	1		1	1
2	3		3	8		4 + 2			3	5

1	1 bhā	1	5 bhā	2		bh⟨ā⟩
2	1	1	1	1	1	
	2		3	4	4	

6

12 33 bhā	1 1	bhāṇḍā 1200	guṇitāṇi ⟨□⟩
1 1	1 360	1	
⟨2⟩ (3)			

43^r F[1] 1 ṣaca(ptadī)
F[2] 1 (9)

IX 4 (43^v)

43^v 1 (. . .)
2 raṃ

2	10	800	adhacch⟨e⟩daṃ 360 di va //
1	1	727	
3	2		

bh⟨āṇ⟩ḍ⟨ā⟩
3 reṇa saha // āyapiṇḍaṃ

2982
486
727

1–15. *Example 2 for Sūtra C9.* 15. Bottom lines of enclosure lost. 18–21. *Example 2 for Sūtra C9.* 19. adhacch⟨e⟩daṃ > ūrdhacch⟨e⟩daṃ.

43v 4 adhunā vyayapiṇḍaṃ

di 1	1807	800
1	240	727

5 ūrdhacchedaṃ 360

6 di va

2982
486
727

puna

800	2982	1
727	486	1
	727	

adhacche

7 daṃ 360 di va //

8 phalaṃ pratidina⟨pra

9 mā⟩ṇaṃ

1807
⟨240⟩

evaṃ sarva trairāśikena //

udā //

43v F[1] 1 □□ṃ □

F[2] 1 □taṃ □

1–6. *Example 2 for Sūtra C9.* 1. 'pra' in margin, to the left of 'adhunā.' 6. Lower half of enclosure lost.
7. *Example 3 for Sūtra C9?*

X 1 (49^v)

49^v 1 ⟨□□ma⟩hāśobhanā □⟨. . .

2 □□□□□□⟩tha rakti kṣayagataṃ si⟨d⟩dh⟨ā⟩rthā
yāsyati bhūtaṃ paṃcaguṇaṃ sa⟨ṃva

3 tsarāṇāṃ tathā m⟩āsaṃ paṃcassamaṃ /
divasāviṃśatikaṃ kiṃ śuṃdyati mahāṃ ⟨ś⟩(o)

4 ⟨bhā⟩ vada niścayaṃ

1	to 3	kṣa	4 +	va 25	che 360
1	mā 2	ya	60	mā 5	1
	12	si	4	12	
	aṃ 3		8	di 20	
	4			30	

ya 3
4
ka 1 1
1 bhā
pā 1 6
⟨4⟩
⟨mū 1⟩
⟨4⟩

madhya⟨bhā⟩

5 garāśi guṇitaṃ jā⟨taṃ⟩

6 ‖ 62321 / 19200 ‖ kṣayaṃ śodhya⟨ṃ jātaṃ⟩

7 ‖ 60881 / 19200 ‖ adhacchedaṃ / 7 tole palaṃḥ 2⟨000 pa bhā //⟩

8 sarva guṇitaṃ ‖ 558278⟨770⟩ / ⟨268800000⟩ ‖

9 ⟨bhaktaṃ bhā 2 / bhāreṇāsti pa

10 2000 bhā pa 153 / palenāsti to 7 pa to 6 / tolenāsti ya 192⟩

1–14. *Example 1 for Sūtra C10.* 1. ⟨. . . About 18 *akṣaras* lost. 2. tha?sva? 7. Enclosure below 'pā 1 6' lost. 1 6 bhā . / 1 bhā > 1 / 6 4 11. Enclosure mostly lost, only upper half of left side being preserved. 13–14. Restored.

X 2 (49r)

49r 1 t⟨o⟩ ya 3 yavanāsti ka ⟨6⟩ kal⟨ā⟩ kal ka 4 kalānāsti pāda

1

4

⟨4 ka pā 1 pā⟩

2 danāsti mūdṛ 4 pā mu mū 2 //

udāharaṇaṃ //

(sva) .i ⟨□□□□⟩

3 mūkhyair=yajaṃti devī prati m=ahni

kacit dadāmi devyā ca t⟨olakai⟩

4 kaṃ caḥ krītvā dīnāra catvāri

ta dhānakā aṃḍikā rakti⟨r=e⟩

5 kā yavā kalā pāda mūdṛkā ca /

etatra mūlyaṃ vada me tatra □

6 sya kiṃ

1 to 12 1	mū 400	dhā 1 aṃ 1 4

ra 1 | 1 bhā
1
4

ya 1 | 3 bhā
⟨1⟩
⟨5⟩

⟨ka 1 | 6 bhā⟩
⟨1⟩
⟨4⟩

⟨pā 1⟩
⟨ 4⟩
⟨mū 1⟩
⟨ 4⟩

padaṃ dī 50 dīnāren⟨ā⟩

7 sti dhāṇe 12 dhā (d)⟨ī⟩

8 ⟨dh⟩ā 10 dhāṇeanāsti aṃ 4 (dhā) aṃ 1 // □⟨□⟩

1–3. *Example 1 for Sūtra C10.* 4–16. *Example 2 for Sūtra C10.* 1. kal⟨ā⟩ kal > ya. 3. pā mu > pāda. 5. sva?ccha? 7–8. t⟨olakai⟩kaṃ?t⟨attola⟩kaṃ? 13. Enclosure below 'ya 1 3 bhā' lost.

X 3 (55ʳ)

55ʳ 1 ⟨□□□⟩ pāda mūdṛkā / (pa)⟨□□□□⟩ th. ⟨□⟩ □□y. ⟨□□□□⟩

2

⟨to 1⟩ 1	va 5 1 3	to dhā	1 1 12	
		aṃ	1 4	
		ra	1	1 bhā 1 4
		ya	1	3 bhā 1 5
		si	1	2 bhā 1 2
		ka	1	2 bhā 1 2
		pā (	1 4⟩	
		⟨mū ⟨	1⟩ 4⟩	

pha va 6 p⟨ā⟩ 7 śve 2 śe (9/10) asya sarva

3 guṇitaṃ ‖ 7227 / 1200 ‖ atha śaḍdrammako (va)

4 jjara dvidhānakai dramam sa⟨p⟩(ta)

5 viṃśatipālāhatai dhānakā / asyaiva skandha⟨sya⟩

6

to 1 1	va 5 1 3	to 1 1	dhā 1 1 12	1	aṃ 1	1 (4)⟨8⟩		

7

ra 1 1	1 60	ya 1 1	1 192	si 1 1	1 480	ka (1) (1)	1 ⟨1200⟩

1–9. *Example 3 for Sūtra C10.* 3. Enclosure below 'pā 1' lost. 8–9. Bottom lines below '(4) . . . 60' and '(1) ⟨1200⟩' lost.

55ʳ 8 ⟨pā 1⟩ ⟨1⟩ (m)⟨ū⟩ (1) 1
⟨1⟩ ⟨4800⟩ ⟨1⟩ ⟨19200⟩

55ʳ F[1] 1 (sapa) 6
F[2] 1 ya
F[3] 1 1 □
F[4] 1 ——

X 4 (55ᵛ)

55ᵛ F[2] 1 (. . .)
2 ś⟨e⟩ | 1 / 40 |
u
55ᵛ dā ⟨//
. . . to⟩lakasya yadā mūlya⟨ṃ drammāḥ⟩
3 paṃ⟨catṛṃśa⟩ ta⟨dā⟩ divardhatolakasya divardha māśakasya di⟨va⟩
4 rdhamāṇḍikā divardhayavasya kiṃ mūlyaṃ /
nyāsa //
5

to 1 / 1	35 / 1	1 to / 1 / 2 / 1 1 mā / 1 6 / 2 / 1 1 aṃ / 1 2 / 2 / 1 1 ya / 1 2 / 2	pha draṃ 58 śe	31 / 128

punānyaṃ

1. *Example 3 for Sūtra C10.* Enclosure lost. 2. 6?m? 5. Broken enclosure on 55ʳF[4], etc. 6–7. Part of *Example 3 for Sūtra C10*? Part of 'ś⟨e⟩ . . . ' on 55ᵛ. Upper half of enclosure lost. 8–16. *Example 4 for Sūtra C10.*

55v 6

to 1	35	1 1 1 1 1 1 192
1	1	1 1 12 1 48 1
		2 2 2 2

7 ⟨pha⟩ draṃ 58 śe

31
128

tathā cānyaṃ

8 (. . .)

55v F[1] 1 t. // u

F[4] 1 ——

X 5 (20r)

20r 1 ⟨. . . ⟩ □□□□□□□□□□□□□ □□□ ||

2 asyaiva ḫ=praṣṇasyā(trā)paro vidhi kṛyate

3

⟨1⟩ 20 rakti	dhā	1	su 1 che 80 rakti su rakti 1
⟨1⟩ 1		1	1 1 1
4	a	0	
	ya	4	
		1	
		4	

pha 4 ya 1 ka ⟨3
dhā

4 pā⟩ (3) mū 1 //

puna tṛtīyasyaiva

2 20	1	1 1
1 1	3	1 1
4	1 1 che 1	
	2 2 2	
	1 che 1	
	4 4	

5 ⟨ūrdha⟩cchedaṃ 6 dhā dra pha dhā 4 ya 1 ⟨ka

6 1⟩ pā 2 mū 1 // suvarṇasya mānaṃ samā⟨ptaṃ //⟩

7 ⟨u⟩dā //

sapaṃcanavabhāgāṇi dināni trayodaśaḥ

⟨□

8 □□□⟩ □(janaka)ṃ □.it. d=⟨r⟩āśīṇāṃ // //

1–3. *Example 4 for Sūtra C10.* 1. 192 > $\frac{1}{192}$. 5. Broken enclosure on 55vF[4]; etc. (Nothing visible on 55vF[3].) 7–10. *Example 5 for Sūtra C10.* 8. Left side of enclosure lost. 9. $\frac{\text{pha}}{\text{dhā}}$ > pha dhā. 11–13. *Example 6 for Sūtra C10.* 11. Right side of enclosure lost. 14–17. *Example 7 for Sūtra C10.*

X 6 (20^v)

20ᵛ 1 ⟨□⟩ □.v.c..y.m. //

(6)4	(va 1)	(yoja) ⟨1⟩ ch⟨e⟩ 76(80)⟨00 aṃ yo⟩
1	1	1 1

⟨pha
2 laṃ⟩ va 12000 /
3 ⟨ud⟩āharaṇaṃ /
śarpo ṣṭādaśahasto
praviśaty=ārdhāṃgulaṃ śanavabh⟨āgaṃ /
4 □⟩ □ti ekaviṃśatibhāgaṃ m=apaharaṃti /
pratidinenaḥ kiṃ kāle
5 ⟨na⟩ vilaṃ saṃprāpyate

1 1	1 1	18 che 24 aṃ ha
2 21 +	1 360	1 1
1		
9		

6 ⟨pha va⟩ 2 mā 4 di 10 ⟨mu 15 //
7 □⟩ □ □//
kīṭaḥ=kilārdhāṃgulaṃ divase divase ⟨□
8 □□□□□□⟩ □□□□□□□□□
śā paṃcāśārdhaṃ ke⟨na kālena //⟩

X 7 (33^r)

33ʳ 1 (. . .)
2 ⟨□□□□⟩ (nava)bhi sārdhai(r=a)phā⟨. . . ⟩
3

(9)	(v)ā 1 che 9 gu va
⟨1⟩	1 1
2	

□⟨□□□⟩ □gha (19)⟨□⟩
33ʳ 4 udā //
dīnārako nāma viśā
5 ⟨la⟩(pa)trī
duḥkhārjanīyaṃ sukhabhojanaṃ ca
tasyārdham=ardhaṃ ca yad=ardham=ardhaṃ
ter(dha) ⟨ta

1–4. *Example 8 for Sūtra C10.* 2. Enclosure after '(80)' lost. 5–12. *Example 9 for Sūtra C10.* 7. ārdhāṃgulaṃ? ardhoṃgulaṃ? 13–16. *Example 10 for Sūtra C10.* 17–20. *Example 11 for Sūtra C10.* 18. A large knot after 'phā.' 19. Beginning of enclosure lost. 21–26. *Example 12 for Sūtra C10.* 26. ter(dha) > ter(dha)ṃ.

33r 6 dardhe⟩na guruprasādaṃ

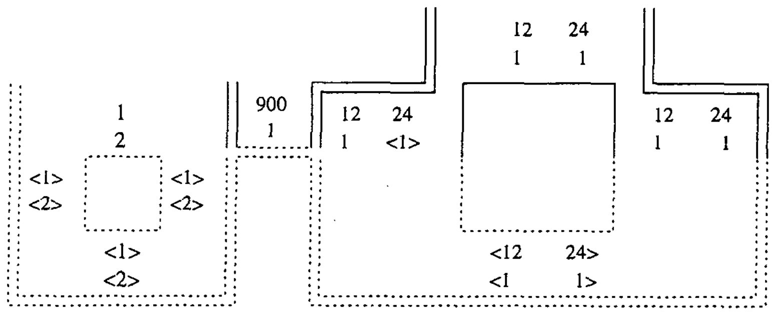
1	1 1 1 1 1 1	108
1	2 2 2 2 2 2	1

pha dī 1 dhā 8 aṃ ⟨1 //

7 eṣa⟩kṛpaṇadhana bhuktaṃ //
ardhaṃ ⟨aṃ

8 gula⟩vistāraṃ nava romaśatāni ca /
dvādaśastīticarmāṇi kati romā(ṇi) ⟨ka

9 thyatāṃ //⟩



pha romā(ṇi)

10 ⟨298598400 //⟩ (. . .)

X 8 (33v)

33v 1 ⟨. . . ⟩ □ // nyā(sa)ṣth⟨āpanaṃ kṛyate /⟩

2

⟨pā⟩ 1	1 ⟨1⟩	gha 12	che 33⟨60 pā gha⟩
1	1 360	1	1

3 ⟨pha va⟩ 112
udā //
sumeru pṛthivīśaṃku surāṇāṃ parimāśrayaṃ //
ārur(o)⟨ha⟩

4 naraḥ=kaści tarasā suramadiraṃ //
satataṃ saptasārdhāṇāṃ sapādavya(rdha)⟨y⟩o

5 ⟨jana⟩ṃ
satṛbhāgatṛpaṃcāṃśa nityam=evaṃ ca gacchati /
yojanānāṃ sahasrā

6 ⟨ṇāṃ⟩ caturāśītir=ucchṛtāṃ /
kena kālena sau gacche vada me ta suniści⟨taṃ //⟩

1–4. *Example 12 for Sūtra C10.* 5–11. *Example 13 for Sūtra C10.* 7. dvādaśastīti > dvādaśahasti. 12–14. *Example 14 for Sūtra C10.* 12. A large knot before '□.' 13. Enclosure, up to the middle of the first cell and after '⟨60,' lost. A large knot before 'gha' in the third cell. 15–24. *Example 15 for Sūtra C10.* 18. madiraṃ > mandiraṃ.

33^{v} 7 ⟨nyāsaḥ⟩

7	di 1	yo 84000	adhacchedaṃ 360 di va
⟨1⟩	1	1	
⟨2⟩			
⟨1⟩			
⟨4⟩			
⟨1⟩			
⟨2 +⟩			
⟨1⟩			
⟨3⟩			
⟨3⟩			
⟨5⟩			

⟨pha va 23

8 mā 4 // . . . ⟩

X 9 (32^{r})

⟨sī⟩

32^{r} 1 tā candranibhāṇanaḥ /

(yoja)⟨nānāṃ ṣaṣṭya⟩

2 (rdhaṃ) tu gaganaṃ nīta rāvaṇe /

na⟨bhasaḥ pātitaṃ va⟩

3 (stra)ṃ tyaktasvabhayasītayā /

sākaikena parāvartaṃ dhanurbhāgaṃ śapa⟨ṃcamaṃ /⟩

4 (pa)vaṇe patamāṇāśau daśabhāgaṃ nidhāryate /

evaṃ tatparimāṇ⟨ena⟩

5 (vi)hīyamānaṃ tu nityaśaḥ

kiyat=astu parāvartaṃ bhūmiṃ prāpya yate japa

6

dha 1 1	parā 1	yoja 30	che 8000 yoja
1 10 +	1	1	1
5			

phalaṃ parā

7 varta

8 ⟨2⟩18181 śe 9/11

udā //

nāga śvacchandagāmī drutamarma (sa) □

9 (. . .)

1–4. *Example 15 for Sūtra C10.* 2. Enclosure for the first cell mostly lost, only its left side for '7' and right side down to '⟨2⟩' being preserved. 5–19. *Example 16 for Sūtra C10.* 6. A large knot between 'ṇa' and 'naḥ.' 20–22. *Example 17 for Sūtra C10.* 21. marma?carma?

X 10 (32ᵛ)

32ᵛ 1 ⟨□□□□⟩ □□□□□□□□□□⟨□□

2 □□□⟩ □□□(sva)yāsugandhite etad=dhi ko⟨vida⟩

3

⟨1⟩ ⟨2⟩	⟨1⟩ ⟨1⟩	100 6 8 3 4000 5 24	ūrdhacche 768000 a yo 1

adhacchedaṃ (3)⟨60

4 pha⟩laṃ va 429867 mā 1 di 4 //

udā //

brahma(lo)⟨ka⟩

5 (pa)rīmuktā patitaṃ bhūmitale paṭaṃ //

tṛśataṃ (yo)⟨janā⟩

6 nāṃ tu saptayojana hīyate /

caturdaśas=tu koṭṭī⟨nāṃ ni⟩

7 yata paṃcaśaṣṭhi ca /

kai dinai bhūtale prāpya ka⟨thaya ga⟩

8 (ṇa)kottamā //

nyāsasthāpanaṃ kṛyate /

9 (...)

X 11 (36ʳ)

36ʳ 1 □yā caturda⟨śa /

□□□□□□□⟩

2 hyā paṃca tṛguṇitā sakhe //

1⟨0⟩ 1	⟨14⟩ ⟨1⟩	⟨15⟩ ⟨1⟩	⟨pha⟩

3 kro 21 eṣa deśapramāṇaṃ samāptaṃ //

1–5. *Example 18 for Sūtra C10.* 1. A large knot in the middle of line. 2. A large knot between 'ga' and 'ndhite.' sugandhite?sraganvite?svagacchite? 3. Enclosure up to the middle of the second cell lost. 6–16. *Example 19 for Sūtra C10.* 17–21. *Example 20 for Sūtra C10.* 17. A large knot after 'rda.' 20. Enclosure for the last two cells lost.

36^r śa(t)i⟨□□□□⟩
4 lavanasya rāṣeko ṣṭatāṃ vākṛtāṃ r=harai /
eṣāṃ caikāṃ rāśi punar=eva ⟨sa⟩
5 ptadhā nītā /
saptāṇāṃ m=api caikā rāśis=tulitāṇi /
paṃcasaptatyā sa
6 hasraṃ bhavet saptāṣṭaguṇaṃ kiṃ

rā 1	1075	56
1	1	1

adhacchedaṃ
7 2000 pa bhā / pha bhā 30 pa 200 // eṣa
8 ⟨rā⟩si lavaṇapramāṇaṃ //
kākinīdaśabhāgasya dadyād=aṣṭādaśī
9 ⟨ka⟩lā /
tasyaṃ viṃśatibhāgaś=ca śatabhāgaṃ prayac⟨cha⟩ti /
naro var⟨ṣa⟩śa⟨te
10 naiva kiṃ dadyād=vada paṇḍita //⟩

36^r F^1 1 □□⟨. . .⟩
2 hinī vada m⟨e . . .⟩
F^2 1 (. . .)

X 12 (36^v)

36^v 1′ □
2′ (ya) 1 ka 1 pā 1

1 ⟨□□□⟩ □□□□□
2 ⟨□□□
kī⟩ṭayā ca yava
3 ⟨trayaṃ kaiḥ sa⟩kh⟨e⟩ yojapaṃcakaṃ /
nyāsa kṛ⟨yate /⟩
4

⟨ya⟩ 3	1 1	yo 5	che 4608000 ya yo
1	1 360	1	1

pha va 21⟨333⟩
5 mā 4 ⟨//

1–11. *Example 21 for Sūtra C10.* 12–16. *Example 22 for Sūtra C10.* 20–21. These lines are written to the upper right corner of 36^v. 22–29. *Example 23 for Sūtra C10.* 22–25. These lines are written to the left of a large knot. 27. Left side of enclosure lost.

36^v udā //⟩

6 yojanasya tṛbhāgārdhaṃ satṛbhāgapadonakaṃ / yā nau dinattṛbhāgena ⟨satribhā⟩

7 gena gacchati / sā punaḥ=paṃcabhāgārdhaṃ yojanasya tathāṣṭamaṃ / (tra)⟨yāho⟩

8 bhi nivartaṃte vāyuvegabalāhatā / yojanānāṃṣṭautaraśataṃ ⟨kena

9 k⟩ālena gacchati

di 1 bhā 1 1 gu 1 1 1 3 bhā	(1)	⟨108⟩
3 3 2 5 2 + 8 +	(1)	⟨1⟩
1 ⟨1 1⟩		
⟨3⟩ ⟨3 4 +⟩		

10 ⟨adhacchedaṃ 360 di

11 va / pha va 1 // ⟩

36^v F[1] 1 □k.t..v.t

F[2] 1 śa | □

X 13 (34^r)

34^r 1

⟨□ □⟩ ⟨□ □⟩ □ (+)	⟨. . .

□□⟩ □□(ni) sasy(āni) ja □⟨□□hi⟩

2 (t)ārthinaḥ khag(ai)r=ekādaś(ai) bhukt(ā) prasṛtiṃ caivam=eva ca / (kh)⟨āryā a⟩

3 ṣṭau vada sakhe kiṃ khagaṃ vada sundari

pra 1	kha 11	khā 8 ⟨che 720⟩
1	1	

4 phalaṃ khaga 63360 eṣa bāhupramāṇaṃ // ⟨udā //⟩

5 kaścit=pumāṃ suvarṇas=tu kalāpādayutaṃ yavaṃ // pratyahaṃ śūline mūrdhni ⟨□□□⟩

1–12. *Example 24 for Sūtra C10.* 8. yojanānāṃṣṭau (ष्ट : o + o) tara > yojanāṣṭotara (= -ottara). 10. Enclosure, except upper parts of both sides of the first cell, lost. 11–12. Restored. 15. Enclosure, except the bottom-right corner, lost. ⟨. . . About 11 *akṣaras* lost. 16–22. *Example 25 for Sūtra C10.* 21. Enclosure after 'khā 8' lost. 23–25. *Example 26 for Sūtra C10.*

34^r 6 kila dattavāṃ /
paṃcābdai māsam=evaṃ tu dinai paṃcadaśas=tathāḥ
datvā ⟨kiṃ ta⟩
7 sya śarvāya jñātum=icchāmi tatvata //

di 1	1		5	(che) ⟨360⟩
1	1	6 bhā	1	
		1	1⟨2⟩	
		4	⟨15⟩	
	1		⟨30⟩	
	4			

8 ⟨a⟩(dha)cchedaṃ 192 yava tola /
9 ⟨phalaṃ to 11 dhā 6 aṃ 1 ya 2 /⟩

X 14 (34^v)

34^v 1 □□⟨p⟩rayu⟨k⟩ta⟨□□□□□□□□□
□□□□□□□□□□⟩
2 c⟨i⟩ttṛtāṃgai /
tānīyatā śarapara⟨ṃ⟩parayā⟨r⟩junena
gṛddhra .ra⟨□□□□□□⟩
3 tayā ṣpṛśaṃnti //

1	śa 1	yo	7 7 7 1	8
8(0)	1	ja	2 2 2 7	1
1				che
9				
1				
5				

phala⟨ṃ⟩ (śa)⟨ra 2⟩
4 940 //
māśakārdhayuto dhyaku
5 ⟨ḍa⟩(va)s=ta paṃcapaṃcāśa satereṇa
vajramaṇaï labdham
6 ⟨a⟩tra kathayasva mūlyaṃ
māṇacaturbhāgasya siddhārthapaṃcada
7 ⟨śabh⟩āgasya //

1–7. *Example 26 for Sūtra C10.* 5. Enclosure for the third (irregular) cell mostly lost; only upper half of its left side being preserved. 7. Restored. 8–16. *Example 27 for Sūtra C10.* 17–22. *Example 28 for Sūtra C10.* 17 dhyaku > dhyardhaku.

34^{v}

ku 1 che 128 mā ku 1 mā che 40 si mā	sa 55
1 1 2	1

8 ⟨□□□⟩ .e □.e □□□□□ū(rdha)c⟨ch⟩edaṃ □□□□//
(va) □⟨□□⟩

X 15 (37^{r})

⟨□
37^{r} 1 □□□□□□⟩ (yo)janā
k⟨o⟩ṭīśat⟨ār⟩dha⟨ṃ⟩ (saratha)⟨ḥ prayāsyāt⟩ /
□□□□□□
2 ⟨□□□□□
saṃ⟩(p)ūyamāṇasya divākarasya
ghaṭikaiḥ=kiṃ prayātasya
va⟨da
3 me ta⟩ suniścitaṃ

30 mu che 2 gha mu	500000000	gha 1
1 1	1	1

pha⟨laṃ⟩
4 yo 83333⟨33⟩
5 śe $\frac{1}{3}$
r=bhāṇo rathaṃ suramahoragasiddhasaṃhai
vidyādharai parivṛtaṃ ⟨divase⟩
6 (ś=ca) rātrau /
koṭīśatārdhaṃ sa rathaṃ prayāsyāt
tad=brūhi śāstrakuśalo ⟨si paṭu⟩
7 (ś=ca) vaktum //
muhūrtamekena kiṃ gacche
brūhi me gaṇakottamā //
8

⟨mu 3⟩0	500000000	gha 2
⟨1⟩	⟨1⟩	⟨1⟩

pha yo 1666666⟨6 śe⟩ $\frac{\langle 2\rangle}{\langle 3\rangle}$

1–3. *Example 28 for Sūtra C10.* 2. .e □.e?.e □6? 4–16. *Example 29 for Sūtra C10.* 17–26. *Example 30 for Sūtra C10.* 5 (yo)janā > (yo)janānāṃ. 20. śatārdhaṃ > śatārdhasamakaṃ. 25. Left side and bottom lines of enclosure lost. 26. Enclosure lost.

X 16 (37^v)

37^v 1 ⟨□□□⟩

⟨va 1⟩	⟨rā 1⟩	⟨di 1⟩	⟨che 1⟩
⟨1⟩	⟨1⟩	⟨1⟩	⟨360⟩

⟨□□□□□□⟩

2 □□□sta bhāga □□□□⟨□□triṃśa⟩

3 bhāge bhaved=rāśi / ūrdhacchedaṃ 108000 viliptāṇā⟨ṃ rāśiḥ / phalaṃ⟩

4 liptā 5

pamcārdhasaṃvatsare bhukte rāśaikā yadi bhānujaḥ

brūhi ⟨gaṇa⟩

5 ka tatvajña samaśvavāsareṇa kiṃ

2	rā 1	1 aṃ 1
1	1	1 360
2		

6 ūrdhacchedaṃ 108000 viliptāṇāṃ

7 ⟨r⟩āśi / adhacchedaṃ 1 viliptā lipta // phalaṃ viliptā
60

2 // e

8 ṣa grahagatiṃ //

udā //

rājā yudhiṣṭhiro nāma ḫ=pāṇḍuvaṃśasamu

⟨dbhavaḥ /

□□□□□□□⟩ ṇi prat⟨yaha⟩ṃ ⟨□⟩ṃ ⟨□□□□//⟩

X 17 (41^v)

41^v 1 (...)

41^v F^4 2 ⟨□□□⟩yet (adhe)

41^v ṣu vidhir=vak⟨ta⟩v⟨ya⟩ṃ // □⟨□□□□□

3 □□⟩

41^v F^4 (na)ṃ (ca k)i(la)

41^v t. □□ṃ u(pa)rādakṛ(y)ā k⟨āryā⟩ 17 2 1 3

1–7. *Example 31 for Sūtra C10.* 2. Enclosure, except bottom lines for the second and the third cells and the bottom-right corner, lost. 8–15. *Example 32 for Sūtra C10.* 10 samaśva > samasta. 13. $\frac{1}{60} > \frac{60}{1}$. phalaṃ viliptā > phalaṃ liptā. 16–19. *Example 33 for Sūtra C10.* 20–25. *Example 34 for Sūtra C10.* 25. '17' on $42^r F^3$.

42^r F^3 tacchedam a⟨dh⟩e

41^v 4 ⟨dāpaye⟩ dvaya 2 adhe dāpaye dattaḥ | 17 / 2 / 2 / 3 | adhenopari

sa̤m(gu)⟨ṇya

5 traye⟩na uparimarāśīdvaya guṇaye | 51 / 5 / 2 / 3 | ⟨c⟩che⟨da⟩ṃ

⟨upari

6 yoja⟩y⟨e⟩t upari yuktaṃ kṛyate ekapaṃcāśānāṃ | 53 / 6 | ⟨□

7 □□⟩ □ / sthāpanaṃ

1	53	2 draṃ	
1	6	1	

phalaṃ ā 17

tṛ 2 //

41^v F^1 1 □□□ / □.i .ai

F^2 1 t cch⟨e⟩da⟨ṃ⟩ □□

F^3 1 (2 dra)

F^4 1 ⟨. . . ⟩yet adhe (□ ⟨. . .

2 . . . ⟩(na)ṃ (ca k)i(la)

F^5 1 // udā // pu

F^6 1 eṣa dhana

X 18 (41^r)

41^r 1 (. . .)

2 ⟨□□□⟩(la)kaṃ (kṛ)yate / □⟨□⟩

41^r F^4 □j. □□⟨□□sa⟩

41^r ptatīnāṃ puru(ṣ)⟨āṇāṃ kā⟩ jī(vyā) □□□□⟨□ // ya⟩

41^r F^4 dy=ekapu⟨ruṣa⟩

41^r 3 sya drammā aṣṭha dvācatvāliṃśabhir=dinai / tat=saptatī⟨nāṃ kim=iti⟩

4

⟨eka⟩sya 42 dine	draṃ 8 jīvyā	70 puruṣā	42 di⟨ne⟩
1	1	1	1

1–8. *Example 34 for Sūtra C10.* 1. Part of 'cche' on 41^v. 7. Bottom lines of enclosure lost. Part of '2 draṃ / 1' on 41^vF^3. 8. The remaining one-line space is left blank. 16–23. *Example 35 for Sūtra C10.* 19. Part of 'ptatīnāṃ puru(ṣ)' on 42^vF^3. 23. Beginning and end of enclosure lost.

X 21 (48^v)

48^v 1

⟨pu 1⟩ ⟨1⟩	pa 5 ⟨to 3⟩ ch⟨e⟩ 8 dhā 2 che 12 guṃ 3 che 5 ya 2	⟨8⟩000⟨0⟩ 1
	3 bhā 1 5	

48^v F[1] adha⟨cchedaṃ 2000 /⟩

48^v phalaṃ bhā 2(1)⟨6 // bhā⟩

2 renāsti pala 2000 bhā / pa 270 // pa⟨l⟩e

3 ⟨nās⟩t⟨i⟩ to 8 tola pal to 6 tolenāsti dhāṇe 12 dh⟨ā to⟩

4 □□8 yadi dinamekena eṣa dataṃ ta dvādaśavarṣeṇa ⟨k⟩i⟨m

5 n⟩yāsa //

di 1 1	216 bhā 270 pa 2000 che 6 to 8 che 8 dhā 12 ⟨che⟩	varṣe 12 3⟨60 che⟩ 1 1

6 phalaṃ bhāra 93⟨3705 //

7 eṣa su⟩varṇapramāṇaṃ y⟨ācitaṃ //⟩

8 ⟨udā //

□□□□⟩.ā śirase śi⟨rase . . . ⟩

48^v F[1] 1

⟨□⟩000⟨□⟩ 1	adha⟨. . . ⟩ (renā)

F[2] 1 pa 5 ||

F[3] 1 (. . .)

1–9. *Example 38 for Sūtra C10.* 1. Enclosure for the first cell lost. 'pa 5' on 48^{v}F^2. '⟨8⟩000⟨0⟩ over 1' on 48^{v}F^1. 4. Part of 'renā' on 48^{v}F^1. 7. Enclosure for the right half of the third cell and bottom lines for the second cell lost. 10–11. *Example 39 for Sūtra C10.*

X 22 (47^v)

47^v 1 (...)
2 ⟨□□□□□□⟩

(śi)ra 1	15 (śa)	10 śi
1	1	1

phalaṃ 150 //

ud⟨ā //
3 samāha⟩tā vyūha pārthaṃ hehaya kī⟨ca
4 ka⟩n⟨i⟩ghna
tasāyakaiś=caiva ẖ=patti svapādadalaśoḍaśai /
a⟨kṣauhi⟩
5 nyā catasrā vai hatā tena mahātmavāṃ //
śarāṇāṃ ca parīmāṇaṃ ⟨vada śa⟩
6 straviśārada

śi 1	16	4 a che 21870
1	1	1 1
	1	
	4	
	1	
	2	

phalaṃ śarā
7 2624400 // anyā⟨kṣau
8 h⟩iṇīpramāṇaṃ // sūtraṃ //
eko ratho gajaś=cai⟨ko
9 narāḥ pañca padātayaḥ /
trayaś=ca turagās=tajjñaiḥ patt⟩i⟨r=ity=a
10 bhidhīyate //
pattiṃ tu triguṇām=etām=āhuḥ senāmukhaṃ budhāḥ /
trīṇi⟩

47^v F^1 1 (...)
F^2 1 .tadhāsti(ta)

X 23 (47^r)

⟨senāmukhāny=eko gulma ity=abhidhīyate
trayo gulmā ga⟩

1–3. *Example 40 for Sūtra C10.* 4–13. *Example 41 for Sūtra C10.* 13–20. *Example 42 for Sūtra C10.* 16–20. Restored (see Sec. 13.2.1 of the Introduction). 21–22. Facsimile ($F^{1,2}$) upside down. 23–24. *Example 42 for Sūtra C10.* Restored.

47r 1 (ṇo nāma vāhinī tu gaṇās)=trayā /
⟨s⟩mṛtā ti⟨s⟩ra⟨s=tu vāhinyaḥ pṛtaneti⟩

2 vicakṣaṇaḥ
camūs=tu pṛtanās=tisras=tisraś=camū⟨s⟩=tu ⟨nīkinī /
a⟩

3 nīkīni daśaguṇām=āhur=akṣāhanī budhaḥ //
akṣohi⟨ṇyāḥ prasaṃkhyānam /⟩

4

ra 1	e	3 3 3 3 3 3 3 10 gu
ga 1	ṣa	1 1 1 1 1 1 1 1
na 5	pa	
tu 3	ti	

guṇita jā

5 (tā)

ratha	21870
gaja	21870
nara	109350
haya	65610

eṣa akṣohi

6 ṇīpramāṇaṃ // //
7 ⟨u⟩dā //
kaścid=rājakumāraśatrudama⟨naḥ
8 □□□□□□□⟩
.i □.o □□⟨□□
9 . . .⟩

47r F1 1 ⟨. . .⟩ □□□□⟨. . .
2 . . .⟩ □(pāda) .i □□(ś)i □ṃ ⟨. . .⟩
F2 1 ⟨. . .⟩ .r. .(y).⟨. . .
2 . . .⟩ □// (śaś)āṃ ⟨. . .⟩

X 24 (42r)

42r 1

⟨20⟩	⟨rū 160⟩	⟨6⟩	⟨. . .
⟨1⟩	⟨1⟩	1	
⟨1⟩		1	
⟨2⟩		2	
1		1	
3		2	

1–11. *Example 42 for Sūtra C10.* 10. Bottom lines of enclosure lost. 12–16. *Example 43 for Sūtra C10.* 17–20. Facsimile ($F^{1,2}$) upside down. 21. *Example 44 for Sūtra C10.* Upper parts of enclosure lost. ⟨. . . About 16 *akṣaras* lost.

42ʳ 2 . . . ⟩ ‖ 40 ‖ 16⟨0⟩ ‖ ⟨. . .⟩
1 1 1
1
□ ⟨□⟩
⟨□⟩

3 pha 54 // ⟨ta⟩tra kr̥yate /

4 ṡaṭ=svār⟨dh⟩ārdhayukte trayodaśa sārdhaṃ bhavati

‖ 40 bhā ‖ 160 ‖ 13 ‖ pha ⟨54 //⟩
1 1 1
2

5 p⟨u⟩nar=api eṣāṃ cchedāṃ kr̥tā jātā ekena rū⟨pa catvā⟩

6 ri sārdhatrayodaśabhi kim=iti ‖ 1 ‖ 4 ‖ 27 ‖ pha 54 eṣāṃ
1 1 2

apa⟨rasya vidhā

7 n⟩e //

ekena labdha catvāri ṣṣaḍbhi saṃpadyate kathaṃ

‖ 1 ‖ ⟨4⟩ ‖ ⟨6⟩ ‖
1 ⟨1⟩ ⟨1⟩

8 ⟨pha⟩ 24 // p⟨u⟩na /

eko labhati catvāri śaṭs⟨v⟩ardhasya tu kiṃ bhavet

9 ‖ ⟨1⟩ ‖ ⟨4⟩ ‖ ⟨3⟩ ‖ ⟨pha 12 // □□□□□□□□□□
⟨1⟩ ⟨1⟩ ⟨1⟩

□⟩ (ta)t=⟨tr⟩īṇisaṃ(pa)ṇ⟨ṇ⟩ā ⟨□□□□□⟩

42ʳ F[1] 1 ⟨ta⟩trārtha(g)ardhasi⟨. . .⟩

2 ‖ ā 1 di 1 1 ⟨. . .⟩
1 1 1
2 (2) ⟨□⟩

F[2] 1 .y.svarāśerguṇī □

F[3] 1 17 | tac⟨ch⟩edam=a⟨dh⟩e

F[4] 1 ‖
vyaya

F[5] 1 40 ‖ 16⟨0⟩

F[6] 1 ⟨. . .⟩ t. □⟨. . .

2 . . .⟩ □⟨□⟩ṃ

1–14. *Example 44 for Sūtra C10.* 1. . . . ⟩ About 10 *akṣaras* lost. Upper parts of enclosure lost. '40' amd '16' on 42ʳF[5]. 10. Enclosure, except left side, lost. 13. Enclosure lost.

42^r F^7 1 pha

X 25 (42^v)

42^v 1 ‖ ⟨1⟩ / ⟨1⟩ ‖ ⟨4⟩ / ⟨1⟩ ‖ 9 1 / 1 2 ‖ ⟨. . .⟩ ‖ ⟨1⟩ / 1 ‖ (4) / 1 ‖ ⟨9⟩ / 2 ‖ ⟨pha 18 //⟩

2 □⟨□□□□⟩ □⟨□□□□⟩ □⟨□□□□⟩

3 (śa) jātā 54 // śaḍbhi 24 // svarā 12 // ardhā 18 // ekattraṃ 54 // eṣa sū

4 trairāśikakaraṇa pratyekamūlyavidhi // aparaṃ vakṣyāmi / viṃśānāṃ di(vasānāṃ)

5 ⟨tu⟩ kiṃ prathame khandhake śveyo bhilikhita / apa^ra^sya prasṇāvidhi

20	1	1
1	1	3
	2	

ma⟨dhya

6 rā⟩śi guṇaye / guṇitā jātā

20	3	1
1	2	3

chedaṃ

20	1	1
1	2	1

bhāge ⟨hṛte⟩

7 jātaṃ phalaṃ rū 10 // viṃśānāṃ diva⟨sānāṃ vya

8 yo⟩ bhavati / atra uparimāskhandhakasya eṣa guṇākāraṃ bhavati / a(ṇya)⟨vidhiṃ⟩

9 likhiṣyāmi / □□□k. □□s. □□k.p. □□m⟨ū⟩l⟨y⟩aṃ (va)ṃ □□□ṃ □⟨□□□□⟩

42^v F^1 1 ⟨. . .⟩ udā // eka □

2 ⟨. . .⟩ □t⟨r⟩ayodaśa

F^2 1 (. . .)

F^3 1 p⟨t⟩atīnāṃ p⟨u⟩ru(ṣ)⟨ānāṃ⟩

F^4 1 t //

F^5 1

9	1
1	2

□

F^6 1 k.ṣ. □

F^7 1

---

1. Facsimile (F^7) upside down. 2–6. *Example 44 for Sūtra C10.* 2. The third cell of the first enclosure on 42^{v}F^5. ⟨. . .⟩ About 11 *akṣaras* lost. Upper parts of the second enclosure lost. 5. sū> sūtra. 7–14. *Example 1 for Sūtra Q11.* 8. apa^ra^sya >aparasya. 9–10. 'ma . . . guṇaye' seems to be part of *Sūtra Q11.* 14–16. *Sūtra N19.* 24. Right margin on F^7.

X 26 (50^v)

50^v 1 ⟨□□⟩ □⟨□□⟩ □⟨□□□□□□□□□⟩ .y.s. □□
□□□⟨□□⟩

2 guṇaye bhājay⟨e⟩ ekar⟨ā⟩(ś)⟨i⟩k⟨e⟩ /

udā //

dramme trapusaśataṃ r=la⟨b⟩dha⟨ṃ⟩

3 ardhena labhyate ẖ=kati /

ekarāśistukalanā

gaṇitaprakṛyā

4 kuruḥ

1	dramme	phalaṃ 50
100	trapusā	
1		
2		

aparāṃ udā //

sārdhadvaye

5 t⟨r⟩aya sārdhadivardhe labhyate ẖ=kati

2
1
2
3
1
3
⟨2⟩
⟨1⟩
⟨2⟩

6 ⟨s⟩ūtraṃ //

adhenopari saṃguṇya

7 ⟨apa⟩varta krameṇa ca /

adheṇa ūrdhaṃ guṇaye ma

8 ⟨dhya⟩mapaṃyasaṃguṇe /

bhājaye r=labdhapanyaṃ ca (pa)

9 (. . .)

1–3. *Sūtra N19* (being continued from X 25). 4–10. *Example 1 for Sūtra N19.* 7. ekarāśistu > ekarāśika. 11–21. *Example 2 for Sūtra N19.* 15–21. *Sūtra Q5.*

X 27 (50^{r})

50^{r} 1 ⟨□□□⟩ □□

□	⟨□⟩
1	□
1	⟨□⟩
4	4

⟨. . .⟩

2 □rtikāvati □⟨likhi⟩(ta)m=i(da)⟨ṃ⟩ vasiṣṭhaputraha
3 sikasyārthe putrapautra upayogyaṃ bhavatuḥ likhi
4 taṃ cchajakaputragaṇakarāje brāhmaṇena /
sarveṣāṃ m=eva śāstrāṇ⟨ā⟩ṃ
5 gaṇitaṃ mūrdhni tiṣṭati /
ādyāvasāne saṃsāre
utpaṃnna ga⟨ṇ⟩i
6 ⟨ta⟩ṃ mahat
paścā śṛṣṭhi tadā kartuṃ
śivena paramātmaṇ⟨ā /
□
7 □⟩.yādyaṃ ca m=utpaṃnnaṃ
gaṇitaṃ sakhyakāraṇaṃ /
yad⟨. □□□□
8 □□
□□⟩ (h)īnaṃ □yad=⟨bha⟩vet
k.āṃ.i □.i.i □□⟨□□□⟩

1. Part of an unidentified example. Upper half of enclosure lost. ⟨. . .⟩ About 12 *akṣaras* lost. 2. rtikāvati?ntikāvati?
2–18. Colophon.

PART III

Translation

Notation

- ⟨A⟩: A has been supplied by me.
- (A): A is an equivalent or explanation of the word or words immediately preceding it.
- □: One syllable or numerical figure unrestorable.
- . . . : Untranslatable portion of the text.
- Sanskrit words such as *sūtra, dīnāra*, etc., as well as the headings for rules and examples, are italicized.

I 1 (70^r)

⟨Example 1 for Sūtra N1.⟩
... 2 *palas*, 0 *tola*, ... 7 ... 2 *palas*, 1 *tola*, ... The sum is 6 *palas*.

Example ⟨2 for Sūtra N1⟩.

> There are three pieces of meat having the same ⟨weight⟩. They are ⟨each⟩ cut into ⟨several⟩ balls: ⟨the first piece⟩ into two, ⟨second⟩ into three, and ⟨third⟩ into four. ... When one has taken three ⟨balls⟩ from it (i.e., one from each group), they weigh thirteen. ... Tell ⟨me⟩. What is ⟨the weight⟩ of each ⟨ball⟩?

$\frac{1}{2}$	$\frac{1}{3}$	$\frac{1}{4}$	visible $\frac{13}{1}$

70^{r}F^1: ... 50 *tolas*. By six ...
70^{r}F^2: ... $\frac{\square}{\square}$, $\frac{\square}{4}$, ... $\frac{35}{2}$. These are the parts(?). 51 ..., $\frac{117}{35}$, $\frac{117}{70}$,[1] ...

I 2 (70^v)

⟨Example 3 for Sūtra N1.⟩
... The sum is 8 *palas*.

Example ⟨4 for Sūtra N1⟩.

> A certain king gave ⟨his three⟩ servants sixty-five *dīnāras* in ⟨the ratio of⟩ a half, a third, and a quarter. What was for each? Let it be told.

$\frac{1}{2}$	$\frac{1}{3}$	$\frac{1}{4}$	visible $\frac{65}{1}$

Reduction of the fractions being made, ...

	□□	result 30
□		

... ⟨The sum is⟩ 65. ...

70^{v}F^1:

□	By means of the principle of shares, the result is ...
6	

70^{v}F^2: ... When one has multiplied ..., the value of the result ... 6. This is ...

1 Similar fractions occur in I 11 (30^v).

I 3 (69ʳ)

⟨*Example 5 for Sūtra N1.*⟩

. . . a king . . . sacrifice(?) . . . equality.

$\frac{2}{5}$	$\frac{2}{6}$	$\frac{2}{7}$	Visible 214.

Here, after the reduction of the fractions has been made, the ⟨common⟩ denominator is the ⟨quantity of⟩ rice (*vrīhaka*), and the numerator ⟨of each fraction⟩ is the ⟨quantity of⟩ unhusked rice (*taṇḍula*). Seven, multiplied by six, is forty-two; twice ⟨that⟩ is eighty-four. This is the ⟨quantity of the first kind of⟩ unhusked rice. Forty-two, multiplied by five, is two hundred and ten. This is the ⟨quantity of⟩ rice everywhere (i.e., for each of the three kinds of unhusked rice). ⟨The sum of the three fractions obtained is taken.⟩ Statement: $\frac{214}{210}$. ⟨By this is⟩ divided ⟨the visible quantity, 214⟩; the result is 210.

Verification by means of the *trairāśika* (Rule of Three):

$\frac{5}{1}$ rice	$\frac{2}{1}$ unhusked rice	$\frac{210}{1}$ ⟨rice⟩	result: $\frac{84}{1}$ unhusked rice

For the second ⟨kind of unhusked rice⟩ is made ⟨the *trairāśika*⟩:

$\frac{6}{1}$ rice	$\frac{2}{1}$ unhusked rice	$\frac{210}{1}$ ⟨rice⟩	result: $\frac{70}{1}$ unhusked rice

For the third ⟨kind of unhusked rice⟩ is made ⟨the *trairāśika*⟩:

$\frac{7}{1}$ rice	$\frac{2}{1}$ unhusked rice	$\frac{210}{1}$ ⟨rice⟩	result: $\frac{60}{1}$ unhusked rice

In total, ⟨the quantity of unhusked rice is⟩ 214.

I 4 (69ᵛ)

⟨*Example 6 for Sūtra N1.*⟩
. . . The sum is 105.

Example ⟨*7 for Sūtra N1*⟩.

> One hundred and thirty ⟨pieces of a certain thing⟩ are ⟨divided⟩ by three shareholders, when ⟨the share of each person is⟩ three times that of the previous one. What is ⟨for each⟩? Let it be told, if you know it.

$\frac{1}{1}$	$\frac{3}{1}$	$\frac{9}{1}$	visible $\frac{130}{1}$

By means of the principle of shares is produced the answer: 10, 30, and 90. The sum is 130.

Example ⟨*8 for Sūtra N1*⟩.

> One hundred and ninety ⟨units of a certain grain⟩ are ⟨divided⟩ by three shareholders, who are either landowners or landed farmers, . . . ⟨What is⟩ the result in this case? Let it be told.

$\frac{4}{1}$	$\frac{6}{1}$	$\frac{9}{1}$	visible $\frac{190}{1}$

By means of the principle of shares is ⟨obtained⟩ the answer: 40, 60, and 90. The sum is 190.

I 5 (68^r)

68^{r}F^1:... place(?) ... should be subtracted; the remainder obtained is 210(?). ... The sum is 324. ... practical(?) ... 2 ... *drammas* ... owner(?) ...

68^{r}F^2:... $\frac{168}{4}$, $\frac{\square}{\square}$, ... Thus, ...

I 6 (68^v)

Blank

I 7 (67^v)

⟨*Example 1 for Sūtra C1.*⟩

> ... property ... Now, when ⟨the merchant⟩ entered ⟨a city⟩, three ⟨monetary units⟩ were given away ⟨as a toll by him⟩; the remaining ⟨property⟩ was made double ⟨through his business in that city⟩; when he departed ⟨the city⟩, four were given away ⟨again as a toll⟩. ... When he entered ⟨another city⟩, four were given away; ⟨his remaining property was⟩ again made double; ⟨when he departed the city, five were given away as a toll; and his⟩ hands became empty. What then was his original property?

$\frac{1}{1}$, $\frac{2}{1}$ divisor, $\frac{2}{1}$	$\frac{2}{1}$, $\frac{2}{1}$ divisor, $\frac{3}{1}$	$\frac{3}{1}$, $\frac{2}{1}$ divisor, $\frac{4}{1}$	$\frac{4}{1}$, $\frac{2}{1}$ divisor, $\frac{5}{1}$	$\frac{0}{1}$

... Zero is increased by five, which has the same denominator; multiplied by half, increased by four, ...

I 8 (67^r)

... $\frac{16}{8}$, $\frac{45}{8}$; the result is $\frac{61}{8}$. ... $\frac{61}{8}$, $\frac{2}{1}$. ⟨The latter is⟩ reduced to the same denominator ⟨thus⟩ | 8 $\frac{2}{1}$, $\frac{16}{8}$ |
The sum is taken of $\frac{16}{8}$ and $\frac{61}{8}$; the result is $\frac{77}{8}$. ... Unity is reduced to the same denominator, $\frac{16}{16}$, and added to $\frac{77}{16}$; the result is $\frac{93}{16}$. This is the answer.

A verification ... in the order ⟨of the statements⟩ of the problem.

$\frac{93}{16}$	$-\frac{1}{1}$, $\times\frac{2}{1}$, $-\frac{2}{1}$	$-\frac{2}{1}$, $\times\frac{2}{1}$, $-\frac{3}{1}$	$-\frac{3}{1}$, $\times\frac{2}{1}$, $-\frac{4}{1}$	$-\frac{4}{1}$, $\times\frac{2}{1}$, $-\frac{5}{1}$	$\frac{0}{1}$

Sūtra ⟨*N2*⟩ for calculating a bill of exchange.

> The difference, divided by the ⟨number of⟩ days, . . . , and multiplication is made. One should point out ⟨the result as⟩ the time for them. By means of the rule of *trairāśika*, . . . What is given as a tax should be kept, and what is given is precisely equal to it(?).

Example ⟨*1 for Sūtra N2*⟩.

> Two . . . property . . .

I 9 (31^r)

⟨*Example 1 for Sūtra C2.*⟩

. . .

Verification by means of the *trairāśika*:

$\frac{2}{1}$ days	3 *drammas* $\frac{1}{2}$	$\frac{168}{11}$ days

Result: $\frac{294}{11}$ *drammas*.

Now, ⟨the *trairāśika*⟩ for the second ⟨person⟩ is made. Statement:

$\frac{3}{1}$ days	2 *drammas* $\frac{1}{2}$	$\frac{168}{11}$ days

Result: $\frac{140}{11}$ *drammas*.

Seven *drammas* are given by the first ⟨person⟩ to the second. By ⟨their⟩ being given, the properties ⟨of the two persons⟩ become equal to each other. The denominator ⟨of the number 7⟩ is ⟨made⟩ equal ⟨to that of the fraction $\frac{294}{11}$⟩. . . . Reduction to the same denominator: $\frac{77}{11}$, $\frac{294}{11}$. ⟨The former⟩ should be subtracted ⟨from the latter⟩; the remainder is $\frac{217}{11}$. The amount to be given is added to the second; the result is:

$\frac{140}{11}$	$\frac{77}{11}$	$\frac{217}{11}$

This has been produced as the property equal ⟨to the one obtained above⟩.

Another ⟨example: *Example 2 for Sūtra C2*⟩.

> Half . . .

of the first: divisor	4 $-\frac{1}{4}$	days, means of livelihood 15 *drammas*
of the second: divisor	3 $\frac{1}{2}$	days, means of livelihood □ *drammas*

I 10 (31^v)

⟨*Example 1 for Sūtra N3.*⟩

. . . reason(?).

⟨ratio⟩	2	1
⟨quantity⟩	unhusked rice 4 per *dramma* $\frac{1}{2}$	kidney beans 6 per *dramma* $\frac{1}{2}$

'. . . multiplied by the divisor (or denominator), . . . increased by the upper ⟨term⟩, is the result of the division' ⟨Sūtra N3?⟩. Two multipliers of this ⟨case⟩ are:

2	1
$\frac{9}{2}$	$\frac{13}{2}$

. . . 'One should multiply the upper by the lower' ⟨Sūtra Q4⟩. First of all, one should multiply . . . two . . . : 2. When ⟨the fraction⟩ two ninths ⟨situated⟩ below ⟨is multiplied⟩ by this, . . .

Under leaf: | □□□ 0 | 2 | multiplied by this . . . One should point out . . . | $\frac{12}{1}$ | $\frac{90}{23}$ □□ | . . .

I 11 (30^v)

. . . property . . . therefore the reduction of the fractions is made. . . . Division is made: | $\frac{234}{70}$ | $\frac{117}{70}$ |
. . .

unhusked rice 3 *ḍhe*[2] $\frac{24}{70}$	kidney beans 1 *ḍhe* $\frac{47}{70}$

. . . is made.

I 12 (30^r)

. . .
Sūtra ⟨*Q8*⟩.

The number of persons, increased by unity, . . .

One should multiply every ⟨term⟩ by six *paṇas*. By means of this ⟨method⟩ is obtained . . . ⟨The following are⟩ obtained severally:

36	42	48	54	60
dha[3] 6	*dha* 7	*dha* 8	*dha* 9	*dha* 10

2 The abbreviation, *ḍhe*, has not been identified.
3 '*dha*' may be an abbreviation of *dhana* (property).

I 13 (28^r)

... edge(?) 4 ... is multiplied by two. One *bhāra* is multiplied by two. ...... ; the result is 14. Again, making ...

Under leaf: ... 17 ... one ... property ... 258 ...

I 14 (28^v)

... shall be ... One twelfth ... one should multiply ⟨by one eighth⟩: $\frac{1}{12}$ times $\frac{1}{8}$ is $\frac{1}{96}$. ... multiplied by eight(?) ... of the one that has no share(?). What is for one and a half? $\frac{1}{96}$, $1\frac{1}{2}$. The result is ... eight, the one that has no share ...

28^vF^2: ... The result is $\frac{5}{9\square}$ ...
28^vF^4: What ... $\frac{1}{96}$ ...

I 15 (66^r)

⟨*Sūtra N4.*⟩

... increased(?) division (or divisor) ...

Example ⟨1 for Sūtra N4⟩.

If one, two, three, four, and six articles, ⟨in order⟩, of five kinds of commodities are ⟨severally obtained⟩ for one ⟨*dramma*⟩, then for how many *drammas* are an equal number of articles ⟨of each kind obtained⟩? Calculate.

Statement is made.

$\frac{1}{1}$ *dramma*, $\frac{1}{1}$	$\frac{1}{1}$ *dramma*, $\frac{2}{1}$	$\frac{1}{1}$ *dramma*, $\frac{3}{1}$	$\frac{1}{1}$ *dramma*, $\frac{4}{1}$	$\frac{1}{1}$ *dramma*, $\frac{6}{1}$

Computation. ... multiplied; the reduction of fractions ... $\frac{12}{1}$, $\frac{6}{1}$, $\frac{4}{1}$, $\frac{3}{1}$, $\frac{2}{1}$.
The remainder ...

I 16 (66^v)

Verification by means of the *trairāśika*:

$\frac{1}{1}$ *dramma*	$\frac{1}{1}$ article	$\frac{12}{1}$ *drammas*	result: 12 articles
$\frac{1}{1}$ *dramma*	$\frac{2}{1}$ articles	$\frac{6}{1}$ *drammas*	result: 12 articles
$\frac{1}{1}$ *dramma*	$\frac{3}{1}$ articles	$\frac{4}{1}$ *drammas*	result: 12 articles
$\frac{1}{1}$ *dramma*	$\frac{4}{1}$ articles	$\frac{3}{1}$ *drammas*	result: 12 articles

...

I 17 (53^r)

⟨*Example 1 for Sūtra N5.*⟩

... the equality of the journeys.

1 *yojanas* for $\frac{1}{1}$ day	*yojanas* traversed by ⟨the first⟩
$\frac{1}{2}$	who has traveled for $\frac{6}{1}$ days: $\frac{9}{1}$

second: $\frac{2}{1}$ *yojanas* for $\frac{1}{1}$ day

Computation. 'The difference of the velocities' ⟨Sūtra N5⟩. In this case, the velocities are $\frac{3}{2}$ and $\frac{2}{1}$; the difference is $\frac{1}{2}$; divided: $\frac{2}{1}$. ... The ⟨distance in⟩ *yojanas* already traversed is 9. One should multiply ⟨the $\frac{2}{1}$⟩ by this; ⟨the result is⟩ 18 ⟨days⟩. In this time, the journey of the one will be equal ⟨to that of the other⟩.

Verification by means of the *trairāśika*:

$\frac{1}{1}$ day	$\frac{3}{2}$ *yojanas*	$\frac{18}{1}$ ⟨days⟩	Result: 27 *yojanas*.

The ⟨number of⟩ days elapsed before is $\frac{6}{1}$; hence ⟨the distance traveled by the first person in that period is⟩ 9 *yojanas*, ⟨and the total distance 36 *yojanas*⟩. ⟨The *trairāśika* for⟩ the second ⟨person⟩:

$\frac{1}{1}$ day	$\frac{2}{1}$ *yojanas*	$\frac{18}{1}$ ⟨days⟩	Result: 36 *yojanas*.

... ⟨A *trairāśika*⟩:

1	8	$\frac{9}{12}$	⟨result:⟩ 6

I 18 (53^v)

⟨*Example 1 for Sūtra C3.*⟩

...

Verification by means of the *trairāśika*, ⟨whose⟩ Statement is made:

$\frac{96}{1}$ days	$\frac{18}{1}$ *yojanas*	20 days + 20 *ghaṭikās* 35 *ghaṭikās* = 1 day	result: $\frac{27}{7}$ *yojanas*
$\frac{100}{1}$ days	$\frac{25}{1}$ *yojanas*	20 days + 20 *ghaṭikās* 35 *ghaṭikās* = 1 day	result: $\frac{36}{7}$ *yojanas*
			total: $\frac{9}{1}$ *yojanas*

... made of bell metal ...

II 1 (54ʳ)

⟨*Example 1 for Sūtra N6.*⟩
...the sum should be taken. The same ⟨amount of⟩ milk(?) ...

$\frac{1}{1}$	$\frac{2}{1}$	$\frac{4}{1}$	$\frac{8}{1}$

...⟨in subtraction⟩, a negative number becomes positive, and in the case of a positive number, it becomes negative. ⟨So has it been said⟩: 'When the sum of the two ⟨kinds of numbers⟩ is taken, there will be the difference' ⟨Sūtra Q10⟩. ...This having been done, the numbers ⟨obtained⟩ are:

$\frac{2}{1}$	$\frac{1}{1}$	$-\frac{2}{1}$	$-\frac{9}{1}$	Visible 82
$\frac{1}{1}$	$\frac{2}{1}$	$\frac{4}{1}$	$\frac{8}{1}$	

...'When one has subtracted the difference from the dividend,' says ⟨Sūtra N6⟩. In the present case, the values of differences, ...The ⟨sum of the⟩ differences is produced as a negative quantity: −8. ...

54ʳF[1]: 'When one has subtracted ⟨the differences⟩ from the dividend' ⟨Sūtra N6⟩.
54ʳF[2]: 'The remainder is divided by the ⟨number of⟩ persons' ⟨Sūtra N6⟩.
54ʳF[6]: ...This ...the property of the ⟨2⟩nd (or ⟨3⟩rd) ⟨person⟩. ...
54ʳF[7]: ... $\frac{1}{1}$ and $\frac{164}{1}$.
54ʳF[8]: The remainder is $\frac{19}{1}$.
54ʳF[9]: The seventh *sūtra*.
54ʳF[10]: ...; the result is 76. This is of the first.
54ʳF[11]: ...a stable for horses ...

II 2 (35ʳ)

...Why? ⟨Because it has been said:⟩ 'When the sum of the two ⟨kinds of numbers⟩ is taken, there will be the difference, and in the case of subtraction the sum ⟨will be taken⟩' ⟨Sūtra Q10⟩. ... 'The remainder is divided by the ⟨number of⟩ persons' ⟨Sūtra N6⟩. The ⟨number of⟩ persons ⟨in the present case⟩ is 15; by this is divided the value ⟨obtained above⟩; $\frac{90}{15}$, to be reduced to 6.

Example ⟨*2 for Sūtra N6*⟩.

...That, increased by two *rūpas*, ...

II 3 (35^v)

... by half the original quantity(?): $1\frac{1}{2}$. This is multiplied by two: 3; increased by two: 5; ... the property of the second. The same, ⟨6⟩, its own half, 3, and its half, $1\frac{1}{2}$, are summed up(?). Statement: ... This is the property of the third. ...

Upper leaf: ... by means of the *trairāśika*:

$\frac{\square}{1}$	...

II 4 (54^v)

⟨*Example 3 for Sūtra N6.*⟩

> ... Half ⟨of three times the property of the second person⟩, multiplied by two and decreased by three, would be the property of the third. ... put together, and ... was purchased for ⟨the sum⟩, twenty-one *dīnāras*, by the ⟨three⟩ persons. Tell ⟨me⟩ the part which ⟨has been contributed by each⟩ individually.

Computation. The ⟨number⟩ whose value is not known is ⟨technically called *yāvattāvat*⟩. ... in *dīnāras*: *yā* $\frac{1}{1}$. This is ⟨supposed to be⟩ the property of the first ⟨person⟩. ...

54^vF^6: ... decreased by three, ...
54^vF^9: He gave ...... in his hands. ...
54^vF^{10}: ... $4\frac{1}{2}$. This ... of all.

$\frac{0}{1}$	$\frac{2}{\square}$	$-\frac{2}{\square}$

II 5 (35#^{r})

... should be subtracted; the remainder ...

$\frac{0}{1}$	$\frac{1}{1}$	$\frac{1}{1}$	Visible 21.
$\frac{1}{4}$	$\frac{3}{2}$	$\frac{3}{1}$	

... 'When one has subtracted the differences from the dividend' ⟨Sūtra N6⟩. The differenes in the present case are: 1, 1; added up: 2. The dividend is 21; from this is subtracted ⟨the sum of the differences⟩: $\frac{19}{1}$. 'The remainder is divided by the ⟨number of⟩ persons' ⟨Sūtra N6⟩. The ⟨number of⟩ persons ⟨in the present case⟩ is: $\frac{1}{4}$, $\frac{3}{2}$, and $\frac{3}{1}$. Their sum, ⟨which is taken⟩ after the reduction of the fractions to the same denominator, is divided: $\frac{4}{19}$; and the value, $\frac{19}{1}$, is multiplied by this, the result being 4. This is the property of the first ⟨person⟩. Half of three times that is multiplied by two: 12; and increased by two: 14. This is the property of the second. ⟨This 14 is⟩ multiplied by half of three: 21; multiplied by two: 42; and decreased by three: 39. This is the property of the third. Statement: 4, 14, 39.

Verification by means of the *trairāśika*: if ⟨each of⟩ four, fourteen, and thirty-nine is to the whole quantity, then what is to ⟨each of⟩ a quarter, a half, and a third?

$\frac{1}{1}$	$\frac{4}{1}$	$\frac{1}{4}$	result: $\frac{1}{1}$
$\frac{1}{1}$	$\frac{14}{1}$	$\frac{1}{2}$	result: $\frac{7}{1}$
$\frac{1}{1}$	$\frac{39}{1}$	$\frac{1}{3}$	result: $\frac{13}{1}$

Thus, ⟨the total is⟩ 21 *dīnāras*. This problem is given ⟨the solution⟩ by these ⟨numbers⟩. ...

Upper leaf 1: ... property. Statement: $\frac{1}{2}$, ...
Upper leaf 2: $\frac{\square}{2}$, $\frac{2}{1}$

II 6 (35#^{v})

⟨*Example 4 for Sūtra N6.*⟩

...

$-\frac{3}{1}$	$-\frac{4}{1}$	$-\frac{5}{1}$	Visible 99.
$\frac{1}{4}$	$\frac{1}{6}$	$\frac{1}{5}$	

... The sum of these (99 and 12) is 111. 'The remainder is divided by the ⟨number of⟩ persons' ⟨Sūtra N6⟩. In the present case, the ⟨number of⟩ persons is: $\frac{1}{4}$, $\frac{1}{6}$, $\frac{1}{5}$. When one has taken the sum ⟨of these fractions⟩ after the reduction to the same denominator, the result is $\frac{37}{60}$; divided: $\frac{60}{37}$. By this is multiplied ⟨the 111⟩; the result is 180. So many cows, horses, and she-buffaloes are separately in the ⟨three⟩ stables.

Verification by means of the *trairāśika*:

$\frac{1}{1}$ stable	$\frac{180}{1}$ cows	$\frac{1}{4}$	result: 45, $-\frac{3}{1}$	= 42
$\frac{1}{1}$ stable	$\frac{180}{1}$ horses	$\frac{1}{6}$	result: 30, $-\frac{4}{1}$	= 26
$\frac{1}{1}$ stable	$\frac{180}{1}$ she-buffaloes	$\frac{1}{5}$	result: 36, $-\frac{5}{1}$	= 31

... Thus, the sum of all ⟨the three terms⟩ is 99.

Upper leaf: ...

Example ⟨*5 for Sūtra N6*⟩.

The property ... less ... property ...

II 7 (51^r)

⟨*Example 6 for Sūtra N6.*⟩

...

$\frac{0}{1}$	$\frac{1}{1}$	$\frac{2}{1}$	$\frac{3}{1}$	visible $\frac{54}{1}$
$\frac{1}{1}$	$\frac{1}{1}$	$\frac{1}{1}$	$\frac{1}{1}$	

'When one has subtracted the differences from the dividend' ⟨Sūtra N6⟩. The differences are: 1, 2, and 3. The sum of these is $\frac{6}{1}$, ⟨which is⟩ subtracted ⟨from the dividend, 54⟩. The remainder produced is 48. 'The remainder is divided by the ⟨number of⟩ persons' ⟨Sūtra N6⟩, that is, by 4; the quotient is 12. This is ⟨the property⟩ of the first ⟨person, and the answer to the problem is⟩: 12, 13, 14, and 15. The sum ⟨of these⟩ is 54.

Example ⟨7 for Sūtra N6⟩.

> O wise man! A certain king gave five horse-men a gift of fifty-seven ⟨monetary units (or pieces of a certain thing) in total⟩. Each person in order, I tell ⟨you⟩, obtained twice the amount for his predecessor and one more. What then was obtained by the first person, and what by each of the others?

$\frac{0}{1}$	$\frac{1}{1}$	$\frac{3}{1}$	$\frac{7}{1}$	$\frac{15}{1}$	visible $\frac{57}{1}$
$\frac{1}{1}$	$\frac{2}{1}$	$\frac{4}{1}$	$\frac{8}{1}$	$\frac{16}{1}$	

51ʳF⁴: $\frac{29}{\square}$
51ʳF⁵: . . . $-\,\square$. This . . . a negative quantity . . .

II 8 (51ᵛ)

⟨Example 8 for Sūtra N6.⟩

$\frac{0}{1}$	$\frac{3}{2}$	$\frac{12}{2}$	$\frac{39}{2}$	$\frac{120}{2}$	visible $\frac{329}{1}$
1	3	9	27	81	

Computation. 'When one has subtracted the differences from the dividend' ⟨Sūtra N6⟩. In the present case, the sum of the values of differences is 87. This value should be subtracted from the visible; the result is 242. 'The remainder is divided by the ⟨number of⟩ persons' ⟨Sūtra N6⟩. The ⟨number of⟩ persons is: 1, 3, 9, 27, and 81. The sum ⟨of these⟩ is 121. By this is divided the remainder: $\frac{242}{121}$; the result is 2. This, two, is the property of the first ⟨person, which, multiplied by each coefficient, is⟩: 2, 6, 18, 54, and 162. . . . ⟨Each of these values is⟩ increased by the ⟨corresponding⟩ difference; the result is: $\frac{2}{1}$, $\frac{15}{2}$, $\frac{48}{2}$, $\frac{147}{2}$, and $\frac{444}{2}$. The sum of these is 329. . . . 329 . . .

51ᵛF³: . . . half . . .
51ᵛF⁵: . . . is received. . . .

II 9 (52ʳ)

⟨Example 9 for Sūtra N6.⟩
. . . $\frac{19}{40}$. Having divided: $\frac{40}{19}$; . . . . . . By this . . . the value, $\frac{57}{1}$. Divided; the result is 3. One should multiply forty by this; the result is 120. So many horses are in ⟨each of the three⟩ troops.

Verification by means of the *trairāśika*:

$\frac{1}{1}$ troop	$\frac{120}{1}$	$\frac{1}{10}$	$\frac{12}{1}$ horses
$\frac{1}{1}$ troop	$\frac{120}{1}$	$\frac{1}{8}$	$\frac{15}{1}$ horses
$\frac{1}{1}$ troop	$\frac{120}{1}$	$\frac{1}{4}$	$\frac{30}{1}$ horses

Thus, ⟨the sum of the three terms is⟩ 57.

Example ⟨1 for Sūtra C4⟩.

> From a certain number, its own half should be subtracted, from the remainder ⟨its own⟩ quarter, and from this remainder one-fifth part ⟨of itself⟩. This ⟨last remainder⟩ plus the sum of two hundred and eighty is exactly ⟨equal to⟩ the original number. What is that original number?

. . .

II 10 (52^v)

. . . 200. Of this, two hundred, a quarter is 50. . . . is a hundred and fifty, 150. Again, one-fifth part of this is 30. Thus, . . .

$\frac{1}{2}$	$\frac{1}{4}$	$\frac{1}{5}$
	$-\frac{1}{2}$	$-\frac{1}{4}$
		$-\frac{1}{2}$

Result: the sum, 280.

Computation of the fifth class is made. . . . the sum, 280. The sum of the fractions is $\frac{28}{40}$; divided, $\frac{40}{28}$. The number, 280, . . . , 400. This is ⟨the value obtained above as⟩ the answer.

III 1 (1^r)

⟨*Example 1 for Sūtra 9.*⟩

... product, 20, ... multiplied by four, and multiplied by five, is the property in hands. Verification ... : ..., multiplied by five, is 25.

⟨The end of⟩ the ninth *sūtra*: 9.

Sūtra ⟨*10*⟩.

The two multipliers are each increased by unity, multiplied by the sum of the beggings, divided by the product of the multipliers less unity, and increased by the opposite beggings. This is a rule for ⟨solving⟩ equations involving ⟨two⟩ multipliers.

Example.

The same *sūtra* has been expounded on the second leaf.[4]

⟨The end of⟩ the tenth *sūtra*: 10.

Sūtra ⟨*11*⟩.

Having subtracted the numerators ⟨separately⟩ from ⟨their own⟩ denominators, one should make their reciprocals, ⟨and then⟩ reduce ⟨the fractions⟩ to the same denominator. Having then discarded ⟨the denominators⟩, one should point out ⟨the numerators⟩ as the properties.

Example ⟨*1 for Sūtra 11*⟩.

A jewel is said to be sold to a group of five merchants. What would be the price of the jewel that is said to be sold in this case? ... a half or a third part or a quarter part or a fifth part or a sixth part.

III 2 (1^v)

... '⟨And then⟩ reduce ⟨the fractions⟩ to the same denominator. Having then discarded ⟨the denominators⟩' ⟨Sūtra 11⟩. The fractions are reduced to the same denominator. ... The result is: $\frac{120}{60}$, $\frac{90}{60}$, $\frac{80}{60}$, $\frac{75}{60}$, and $\frac{72}{60}$. 'Having then discarded ⟨the denominators⟩' ⟨Sūtra 11⟩. The result is: 120, 90, 80, 75, and 72. The sum of these is taken; the result is 437. Sixty having been subtracted from this, the remainder is 377. This is the price of the jewel.

⟨The price of the jewel is also calculated from⟩ the total sum of the properties of four[5] ⟨merchants and from the given part of the property of the remaining one⟩. Half of the property of the first

4 The leaf is missing.

5 This phrase may be a citation from the verse of Example 1.

⟨merchant⟩ is 60. ⟨The properties of the other four merchants are:⟩ 90, 80, 75, and 72. The sum of the four ⟨merchants⟩, 317, is increased by half of the first's, i.e., by sixty: 377. ⟨This is⟩ the property of the first.[6] The total sum of the property of the first and those of the third, fourth, and fifth is 347, ⟨which is⟩ increased by a third part of the second's, 30. The result is 377. This is the property of the second. Again, the total property of the first, second, fourth, and fifth is 357, and a quarter of the third's is 20. ⟨The former⟩, increased by this, is 377. This is the property of the third. Again, ⟨the total sum of the properties of⟩ the first, second, third, and fifth is 362. ... This ... Again, ...

III 3 (2ʳ)

... is the property of the ...

Now, ⟨the Statement⟩ of the first ⟨case⟩ is made:

120	Added up; the result is 437. Sixty should be subtracted from this;
90	the remainder is 377.
80	
75	
72	

Now, ⟨the Statement⟩ of the second ⟨case⟩:

120	⟨where⟩ one third ⟨of the property of the second merchant⟩ is
30	taken. ⟨The sum is ⟩ 377, ⟨which is⟩ the property of the second.
80	
75	
72	

Now, ⟨the Statement⟩ of the third ⟨case⟩ is made:

120	Thus, ⟨the sum is ⟩ 377, ⟨which is⟩ the property of the third.
90	
20	
75	
72	

⟨The Statement⟩ of the fourth ⟨case⟩ is made.

120	Thus, ⟨the sum is ⟩ 377, ⟨which is⟩ the property of the fourth.
90	
80	
15	
72	

The Statement of the fifth ⟨case⟩ is made.

120	Thus, ⟨the the property⟩ of the fifth is 377. This is the price of
90	the jewel, ⟨which is the same⟩ in every case.
80	
75	
12	

6 This statement as well as similar ones in the succeeding passage is probably a mistake due to the commentator.

Example ⟨2 for Sūtra 11⟩.

A group of three merchants, who know each other's property, ... less three quarters ... and ...

III 4 (2^v)

...	$-\frac{7}{12}$	$-\frac{3}{4}$	$-\frac{5}{6}$

...	$\frac{-7}{12}$	$\frac{-3}{4}$	$\frac{-5}{6}$
	12	4	6

'Having subtracted the numerators' ⟨Sūtra 11⟩. One should subtract ⟨each of those⟩ standing as negative. This ⟨calculation⟩ is conducted: $\frac{19}{12}$, $\frac{7}{4}$, and $\frac{11}{6}$. 'One should make their reciprocals' ⟨Sūtra 11⟩: $\frac{12}{19}$, $\frac{4}{7}$, and $\frac{6}{11}$. '⟨And then⟩ reduce ⟨the fractions⟩ to the same denominator' ⟨Sūtra 11⟩. ⟨This is⟩ done; the result is: $\frac{924}{1463}$, $\frac{836}{1463}$, and $\frac{798}{1463}$. 'Having then discarded ⟨the denominators⟩' ⟨Sūtra 11⟩. The result is: 924, 836, and 798. The sum of these is taken. ... is made; the result is 2558. The ⟨common⟩ denominator should be subtracted ⟨from this⟩: 1095. This is the price of the jewel.

III 5 (3^v)

⟨*Example 1 for Sūtra 13.*⟩

... ⟨The first merchant has seven *aśva* horses⟩, the second nine *haya* horses, and the third ten camels. ... ⟨Their properties in cash value become equal to one another⟩ after the mutual exchange ⟨of one animal⟩. Since you are able to tell the property of each of the ⟨three⟩ merchants or the price of each kind of animals, therefore remove my doubt ⟨about these points⟩.

$\frac{7}{1}$ *aśva* horses[7]	$\frac{9}{1}$ *haya* horses	$\frac{10}{1}$ camels	3 merchants.

'The ⟨number of things⟩ to be given ⟨by each merchants⟩, multiplied by the number of merchants' ⟨Sūtra 13⟩. The ⟨number of each⟩ commodity is: 7, 9, and 10. ⟨From each of these⟩, the ⟨number of things⟩ to be given ⟨multiplied by⟩ 3 is subtracted; the remainders are: 4, 6, and 7. These are multiplied by one another; the result is: 168, 168, and 168. 'Divided by their own remainders' ⟨Sūtra 13⟩. This is done: $\frac{168}{4}$, $\frac{168}{6}$, $\frac{168}{7}$; the quotients are: 42, 28, 24. These are the unit-prices of each ⟨kind of animals⟩. ⟨These numbers are⟩ each multiplied by their own sums; produced are 294, 252, and 240, ⟨which are the cash values that may be obtained in order⟩ by means of the *aśva* horses, *haya* horses, and camels. The sum of these is divided by three; the result is: 262, 262, and 262. These have been produced as the equal properties ⟨of the three merchants⟩.

---

7 The manuscript reads '7' for '$\frac{7}{1}$.'

III 6 (3^r)

⟨*Example 2 for Sūtra 13.*⟩

> . . . When ⟨each⟩ has given . . ., ⟨their⟩ properties become equal to one another. Let the prices per *prastha* be told.

areca nuts $\frac{4}{1}$	wheat $\frac{5}{1}$	rice $\frac{6}{1}$	⟨measured in *prasthas*⟩

. . . The prices per *prastha* are: 2, 3, and 6.[8] 'When ⟨each⟩ has given, ⟨their⟩ properties become equal to one another' ⟨Example 2⟩: 17, 17, 17.

⟨The end of⟩ the thirteenth *sūtra*: 13.

Sūtra ⟨*14*⟩.

> The number of persons is increased by unity, and . . . two . . . The same ⟨operation⟩ should be repeated until ⟨the result⟩ becomes equal to the ⟨number of⟩ persons(?).

. . . has been written on the . . .th leaf.

⟨The end of⟩ the fourteenth *sūtra*: 14.

Sūtra ⟨*15*⟩.

> The difference of the velocities is divided by the distance traveled before. With this very ⟨computation⟩ will be ⟨obtained⟩ the time, when the distances traversed are the same.

Example ⟨*1 for Sūtra 15*⟩.

> When ⟨a person⟩ has gone one and a half *yojanas*, hundred times(?) . . .

III 7 (4^r)

. . . the second . . .

⟨*Example 2 for Sūtra 15.*⟩

> . . . five *yojanas*. When he has gone for seven days, the second ⟨person⟩, of ⟨whom the speed is⟩ nine *yojanas* ⟨a day, departs⟩. Then, in how many days is there equality ⟨of the distances traveled by each⟩?

8 These results correspond to the three terms in the enclosure in the reverse order.

$\frac{1}{1}$ day, $\frac{5}{1}$ *yojanas*	*yojanas* traversed by ⟨the first⟩ who has traveled for $\frac{7}{1}$ days: $\frac{35}{1}$

second: $\frac{1}{1}$ day, $\frac{9}{1}$ *yojanas*

'The difference of the velocities' ⟨Sūtra 15⟩. ... The velocities: 5, 9. The difference: 4. Divided: $\frac{1}{4}$. The distance traversed before: 35 ⟨*yojanas*⟩. This is multiplied by the quarter: $\frac{35}{4}$. In so many days, the nine-*yojana* ⟨goer⟩ gets his journey equal ⟨to the other's⟩.

Verification by means of the *trairāśika*:

$\frac{1}{1}$ day	$\frac{5}{1}$ *yojanas*	$\frac{35}{4}$ ⟨days⟩	result: $\frac{175}{4}$ ⟨*yojanas*⟩
$\frac{1}{1}$ day	$\frac{9}{1}$ *yojanas*	$\frac{35}{4}$ ⟨days⟩	result: $\frac{315}{4}$ ⟨*yojanas*⟩

Example ⟨3 for Sūtra 15⟩.

One goes eighteen *yoajanas* a day. When he has proceeded for eight days, another person ⟨departs from the same place, and⟩ goes twenty-five *yojanas* a day. In what time is there equality of the distances traversed?

The same ⟨example⟩ has been written also on the eleventh leaf above.[9]

⟨The end of⟩ the fifteenth *sūtra*: 15.

Sūtra ⟨16⟩.

The difference of the first terms should be made; ⟨and the result⟩ is divided by the difference of the common differences. By the common differecne(?) ...

⟨Example 1 for Sūtra 16.⟩

... The period is missing. The equality of the distances traversed ...

III 8 (4^v)

... The difference: $\frac{2}{1}$. Divided: $\frac{1}{2}$. The difference of the first terms: $\frac{2}{1}$. The result ⟨of the multiplication⟩ is: $\frac{1}{1}$. Multiplied by two: 2. Increased by unity: 3. This is the period in the summation ⟨of the two arithmetical progressions⟩.

Verification. The period, ⟨3, which was⟩ missing ⟨in the problem⟩, should be placed in both ⟨vacant places of the Statement⟩.[10] By means of the *Minus-One* method ⟨Sūtra Q12⟩ is ⟨obtained⟩ the result: 21 ⟨for the first progression⟩ and 21 ⟨for the second too⟩. ⟨Similar problems⟩ have been written also on the twentieth leaf(?) above.

9 The leaf is missing, but cf. Example 1 for Sūtra N5 in I 17.

10 Cf. the 'Statement' of Example 1 for Sūtra 17.

⟨The end of⟩ the sixteenth *sūtra*: 17.
There is a corruption in the ⟨numbering of this⟩ *sūtra*.[11]

Example ⟨1 for Sūtra 17⟩.

The first term ⟨of the first progression⟩ is two, and the common difference three. The common difference of the second ⟨progression⟩, the first term of which is three, is two. In what time do the distances traversed ⟨according to the two arithmetical progressions just defined⟩ attain equality?

Statement is made:

first term $\frac{2}{1}$	common diff. $\frac{3}{1}$	period $\frac{0}{1}$

second: first term $\frac{3}{1}$	common diff. $\frac{2}{1}$	period $\frac{0}{1}$

Computation. 'The difference of the first terms is multiplied by two' ⟨Sūtra 17⟩. ...

III 9 (5^r)

⟨Example 1 for Sūtra 18.⟩

...

first term $\frac{5}{1}$	common diff. $\frac{6}{1}$	period $\frac{0}{1}$	sum $\frac{0}{1}$
first term $\frac{10}{1}$	common diff.[12] $\frac{3}{1}$	period $\frac{0}{1}$	sum $\frac{0}{1}$

Computation. 'The differecne of the first terms' ⟨Sūtra 18⟩. The first terms: 5, 10. The difference: 5. 'The difference of the common differecnes' ⟨Sūtra 18⟩. The common differecnes: 6, 3. The difference: 3. The difference of the first terms, 5, is multiplied by two: 10; divided by the difference of the common differences, 3: $\frac{10}{3}$; and increased by unity: $\frac{13}{3}$. In this time is there equality of the properties.

Verification by means of the *Minus-One* method. Result: 65 ⟨for the first progression⟩ and 65 for the second ⟨also⟩. This is the amount of property which is the same ⟨for both persons⟩.

⟨The end of⟩ the eighteenth *sūtra*: 18.

⟨Sūtra 19.⟩

The daily ⟨constant⟩ journey is decreased by the first term, multiplied by two, and increased by the common difference; ⟨the result is called⟩ *pratinihita* ('substituted'), which, when multiplied by itself, becomes a quantity called *kṣepa* ('addendum'). When one has added what is called *kṣepa* to the product of eight, the common difference, ⟨and the distance traveled by the first man before the departure of the second⟩, the square root ⟨of the result⟩ is increased by the *pratinihita*, and divided by twice the common difference.

---

11 This note is written by the same hand.
12 The manuscript reads '3' for '$\frac{3}{1}$.'

⟨The end of⟩ the sixteenth *sūtra*: 17.
There is a corruption in the ⟨numbering of this⟩ *sūtra*.[11]

Example ⟨1 for Sūtra 17⟩.

The first term ⟨of the first progression⟩ is two, and the common difference three. The common difference of the second ⟨progression⟩, the first term of which is three, is two. In what time do the distances traversed ⟨according to the two arithmetical progressions just defined⟩ attain equality?

Statement is made:

	first term $\frac{2}{1}$	common diff. $\frac{3}{1}$	period $\frac{0}{1}$
second:	first term $\frac{3}{1}$	common diff. $\frac{2}{1}$	period $\frac{0}{1}$

Computation. 'The difference of the first terms is multiplied by two' ⟨Sūtra 17⟩. ...

III 9 (5^r)

⟨*Example 1 for Sūtra 18.*⟩

...

first term $\frac{5}{1}$	common diff. $\frac{6}{1}$	period $\frac{0}{1}$	sum $\frac{0}{1}$
first term $\frac{10}{1}$	common diff.[12] $\frac{3}{1}$	period $\frac{0}{1}$	sum $\frac{0}{1}$

Computation. 'The differecne of the first terms' ⟨Sūtra 18⟩. The first terms: 5, 10. The difference: 5. 'The difference of the common differecnes' ⟨Sūtra 18⟩. The common differecnes: 6, 3. The difference: 3. The difference of the first terms, 5, is multiplied by two: 10; divided by the difference of the common differences, 3: $\frac{10}{3}$; and increased by unity: $\frac{13}{3}$. In this time is there equality of the properties.

Verification by means of the *Minus-One* method. Result: 65 ⟨for the first progression⟩ and 65 for the second ⟨also⟩. This is the amount of property which is the same ⟨for both persons⟩.

⟨The end of⟩ the eighteenth *sūtra*: 18.

⟨*Sūtra 19.*⟩

The daily ⟨constant⟩ journey is decreased by the first term, multiplied by two, and increased by the common difference; ⟨the result is called⟩ *pratinihita* ('substituted'), which, when multiplied by itself, becomes a quantity called *kṣepa* ('addendum'). When one has added what is called *kṣepa* to the product of eight, the common difference, ⟨and the distance traveled by the first man before the departure of the second⟩, the square root ⟨of the result⟩ is increased by the *pratinihita*, and divided by twice the common difference.

11 This note is written by the same hand.
12 The manuscript reads '3' for '$\frac{3}{1}$.'

⟨Example 1 for Sūtra 19.⟩

. . .

III 10 (5^v)

. . . sixty times five: 30.

Computation. 'The daily ⟨constant⟩ journey is decreased by the first term' ⟨Sūtra 19⟩. The daily journey in *yojanas* is five: 5. Decreased by the first term, $\frac{3}{1}$, it becomes 2. 'Multiplied by two': 4; 'and increased by the common difference': 8. ⟨This is what is called⟩ *pratinihita*, ⟨which is⟩ multiplied by itself: 64. This is the quantity called *kṣepa*, ⟨which is to be added⟩ 'to the product of eight, the common difference, ⟨and the distance traveled by the first man before the departure of the second⟩' ⟨Sūtra 19⟩. The quantity obtained ⟨above as the distance traveled by the first man⟩ is 30. Multiplied by eight: 240. ⟨This is again⟩ multiplied by the common difference. The common difference ⟨in the present case⟩ is 4. By this is multiplied ⟨the 240⟩; the result is 960. 'When one has added what is called *kṣepa*' ⟨Sūtra 19⟩. What is called *kṣepa* in the present case is 64. Increased ⟨by this⟩, it becomes 1024. Its 'square root,' 32, 'is increased by the *pratinihita*.' The *pratinihita* is 8. Increased ⟨by this⟩, it becomes 40. The common difference, 4, is multiplied by two: 8. Divided by this, it becomes 5. In so many days is traveled the same distance ⟨by the two persons⟩.

III 11 (6^r)

. . .

Verification by means of the *trairāśika*:

$\frac{1}{1}$ ⟨day⟩	$\frac{5}{1}$ ⟨*yojanas*⟩	$\frac{5}{1}$ ⟨days⟩

Result: 25 *yojanas*.

The distance traveled before is 30 ⟨*yojanas*⟩. Together with this, it is 55 ⟨*yojanas*⟩. This is the same distance traveled ⟨by the two men⟩.

Example ⟨2 for Sūtra 19⟩.

A certain man goes ⟨by increasing his daily journey in accordance with the arithmetical progression whose ⟩ first term is five *yojanas*, and the common difference three *yojanas*. Another man ⟨goes constantly⟩ seven ⟨*yojanas*⟩ every day. When ⟨the latter⟩ has traveled for five days, ⟨the former departs from the same place.⟩ In what time is there equality ⟨of the distance traveled by each⟩? O best of mathematician! Let it be told.

Statement:

first term $\frac{5}{1}$	common diff. $\frac{3}{1}$	period $\frac{0}{1}$	daily journey[13] $\frac{7}{1}$

5 days; five-day journey of the seven-*yojana* traveler: 35 *yojanas*

13 The manuscript reads '7' for '$\frac{7}{1}$.'

Computation. 'The daily ⟨constant⟩ journey is decreased by the first term' ⟨Sūtra 19⟩. The daily journey in the present case is 7. 'Decreased by the first term.' The first term is 5. Decreased ⟨by this⟩, it becomes 2. ...

III 12 (6^v)

... ⟨The common difference is⟩ 3. Multiplied by this, it becomes 840. 'When one has added what is called *kṣepa*' ⟨Sūtra 19⟩. The value of the *kṣepa* in the present case is 49. When one has added ⟨this to the 840⟩, it becomes 889. This does not give an exact square root. The square root is, ⟨therefore⟩, calculated ⟨approximately by means of the following method⟩.

Sūtra ⟨*Q2*⟩.

> The divisor for the remainder from the diminution of the non-square number by the square of the first approximation, is twice ⟨the first approximation⟩. Division of half the sqaure of that ⟨quotient⟩ by the second approximation ⟨just obtained is made⟩. Subtraction ⟨of the result from the second approximation gives the third approximation⟩. Less the square.

O man of intellect! Calculate an approximate square root by means of this *sūtra*. The square root obtained is $29\frac{48}{58}$. The *pratinihita* is 7. Increased by this: $36\frac{48}{58}$. Reduced to the same color: $\frac{2136}{58}$. 'Divided by twice the common difference' ⟨Sūtra 19⟩. The common difference in the present case is 3. Multilpied by two: 6. Divided by this, it becomes $\frac{356}{58}$. This is the period ⟨of the arithmetical progression⟩.

III 13 (7^r)

...

6	days
1	
8	*ghaṭikās*
60	
16	*caṣakas*
60	
33	*liptās*
60	
6	*viliptās*
60	
remainder:	$\frac{6}{29}$

Verification by means of the *Minus-One* method ⟨Sūtra Q12⟩. 'The number of terms' is $\frac{178}{29}$. 'Minus one': $\frac{149}{29}$. 'Multiplied by the common difference.' The common difference in the present case is 3. Multiplied ⟨by this⟩, it becomes $\frac{447}{29}$. 'Halved': $\frac{447}{58}$. 'Increased by the first term.' The first term in the present case is 5. Increased ⟨by this⟩ after the reduction to the same denominator: $\frac{737}{58}$. 'Multiplied by the period.' The period in the present case is $\frac{178}{29}$. Multiplied by this, it becomes

$\frac{65593}{841}$. ⟨This is⟩ an approximation ⟨to the sum of the progression⟩. ⟨Therefore⟩, by subtracting the square, the remainder is obtained: $\frac{65569}{841}$. The division having been made, the result is $77\frac{28}{29}$.

Verification ⟨leading⟩ to the equal journeys by means of the *trairāśika*:

$\frac{1}{1}$ ⟨day⟩	$\frac{7}{1}$ *yojanas*	$\frac{178}{29}$ ⟨days⟩

The result produced is 42 *yojanas* and the remainder $\frac{28}{29}$. The constant, ⟨35 *yojanas*⟩, is increased by this; the result produced is $77\frac{28}{29}$.

⟨The end of⟩ the nineteenth *sūtra*: 19.

III 14 (7^v)

⟨*Example 1 for Sūtra 20.*⟩

... of what is lustrous.

first term $\frac{3}{1}$	common diff. $\frac{4}{1}$	period $\frac{0}{1}$	constant donation $\frac{7}{1}$

'When one has subtracted the first term from the constant ⟨donation⟩' ⟨Sūtra 20⟩. When one has subtracted the first term, 3, ⟨from⟩ the constant ⟨donation⟩, 7, ⟨the result is⟩ 4. 'Divided by half the common difference' ⟨Sūtra 20⟩. The common difference is 4, and its half 2. Divided by this: $\frac{4}{2}$; the result is 2. 'The quotient is increased by unity' ⟨Sūtra 20⟩. That, increased by unity, is 3. This should be known as the time, ⟨in which the total donations made by each become equal to each other⟩.

Verification.

first term $\frac{3}{1}$	common diff. $\frac{4}{1}$	period $\frac{3}{1}$

The result ⟨obtained⟩ by means of the *Minus-One* method is 21 *rūpakas*.

Verification concerning the second ⟨person is made⟩ by means of the *trairāśika*:

$\frac{1}{1}$ day	$\frac{7}{1}$ ⟨*rūpakas*⟩	$\frac{3}{1}$ days

Result: 21 *rūpakas*.

This has been produced as the same amount of money ⟨donated by each⟩.

Example ⟨*2 for Sūtra 20*⟩.

> ⟨A certain man donates in accordance with the arithmetical progression whose⟩ first term is one and the common difference is two. Another ⟨donates⟩ five every day. In what time is there equality ⟨of the donations made by each⟩? O best of mathematician! Let it be told.

first term $\frac{1}{1}$	common diff. $\frac{2}{1}$	period $\frac{0}{1}$	constant donation $\frac{5}{1}$

'When one has subtracted the first term from the constant ⟨donation⟩.' ⟨Sūtra 20⟩. ...

III 15 (8^r)

⟨The end of⟩ the twentieth *sūtra*: 20.

Sūtra ⟨21⟩.

Twice the first term is subtracted from twice the constant ⟨income⟩. Then, one should divide the remainder by the common difference, and point out the quotient ⟨plus⟩ unity ⟨as the time when equality of the earnings made by each person is arrived at⟩.

Example ⟨1 for Sūtra 21⟩.

There is a hired servant. He works for ten *māṣakas* every day. There is another servant, ⟨whose⟩ work is done for two ⟨*māṣakas*⟩ on the first ⟨day and whose earnings⟩ increase by three ⟨*māṣakas* every succeeding day⟩. The period thereof is, however, not known. In what time is equality ⟨of the earnings made by each person arrived at⟩?

first term $\frac{2}{1}$	common diff. $\frac{3}{1}$	period $\frac{0}{1}$	$\frac{10}{1}$ each ⟨day⟩

Computation. 'Twice the first term is subtracted' ⟨Sūtra 21⟩. The first term, 2, is multiplied by two: 4. The constant ⟨income⟩ is also multiplied by two: 20. ... The result is 16. 'One should divide the remainder by the common difference' ⟨Sūtra 21⟩. ...

III 16 (8^v)

⟨The end of⟩ the twenty-first *sūtra*: 21.

Sūtra ⟨22⟩.

When one has divided the distance to be traversed by the ⟨number of⟩ horses and multiplied ⟨the result⟩ by the ⟨number of animals⟩ called horses yoked to the chariot at a time, ⟨the result⟩ should be known as the distance in *yojanas* traveled by one horse.

Example ⟨1 for Sūtra 22⟩.

A chariot is to be pulled by ten horses ⟨in total⟩. Five horses are yoked ⟨to it at a time⟩. The distance to be traveled ⟨by the chariot⟩ is one hundred *yojanas*. Then, for what ⟨distance⟩ does one horse appear ⟨for pulling the chariot⟩?

$\frac{10}{1}$ horses	of the chariot with horses	to be traveled
	$\frac{5}{1}$ ⟨horses⟩	$\frac{100}{1}$ *yojanas*

Computation. 'When one has divided the distance to be traversed' ⟨Sūtra 22⟩. The ⟨number of⟩ horses in the present case is 10, and the distance to be traveled 100 *yojanas*. When, therefore, one has divided, the quotient is 10. The ⟨number of the⟩ yoked horses in the present case is 5. When one has multiplied ⟨the quotient⟩ by this, it becomes 50. For so many *yojanas* is one horse burdened.

Verification. When one has multiplied a hundred by five, the result is 500. A *trairāśika* is made: if ten horses ⟨go⟩ five hundred *yojanas*, then how far does one horse go?

10	500	1

Result: 50 *yojanas*.

III 17 (9^r)

⟨*Sūtra 23.*⟩

> ⟨When one has doubled the gains⟩ and ⟨decreased the result by twice the first term, the result⟩ is divided by the common difference and increased by unity. This is what is called a question.

Example ⟨1 for Sūtra 23⟩.

> . . . has been obtained by twice-born men. When, however, they have divided those equally ⟨among themselves⟩, each ⟨Brāhmaṇa⟩ obtained ten. What is the number ⟨of those obtained by them⟩? Tell me. How many Brāhmaṇas were there? . . .

first term $\frac{1}{1}$	common diff. $\frac{1}{1}$	period $\frac{0}{1}$	gains $\frac{10}{1}$

Computation. 'When one has doubled the gains' ⟨Sūtra 23⟩. The gains in the present case is 10. Doubled: 20. Also decreased by two: $\frac{18}{1}$. '⟨The result⟩ is divided by the common difference' ⟨Sūtra 23⟩. The common difference in the present case is 1. When one has divided ⟨the 18⟩ by this, the result is the same, $\frac{18}{1}$. 'Increased by unity': $\frac{19}{1}$. This ⟨number⟩, nineteen Brāhmaṇas, is the 'question.'

Statement ⟨for⟩ the computation of . . .:

first term $\frac{1}{1}$	common diff. $\frac{1}{1}$	period $\frac{19}{1}$

The result ⟨obtained⟩ by means of the *Minus-One* method is 190.

III 18 (9^v)

⟨*Example 1 for Sūtra 24.*⟩

> . . . *yojana* . . . going with a chariot . . .

fast $\frac{6}{1}$ *yojanas*	slow $\frac{1}{1}$ *yojana*	70 *yojanas* to be traveled

'The sum of the ⟨daily⟩ journeys,' $\frac{7}{1}$, is divided: $\frac{1}{7}$. The distance to be traveled is 70. Multiplied by this; the result obtained, 10, is doubled: 20. This is ⟨the time⟩ for the slow⟨-goer to meet the fast-goer⟩.

Now, ... This should be known as the time. In this time is the meeting of the one-*yojana* goer and the six-*yojana* goer, who, having surpassed the distance to go, ⟨is on his return journey⟩.

Thus, the verification ⟨is made⟩ by means of the *trairāśika*: if six *yojanas* are for one ⟨day⟩, then what is for twenty ⟨days⟩?

$\frac{1}{1}$ ⟨day⟩	$\frac{6}{1}$ *yojanas*	$\frac{20}{1}$ ⟨days⟩

Result: $\frac{120}{1}$ *yojanas*.

From this, seventy should be subtracted; the remainder ⟨is the return journey of the fast-goer⟩. Here is seventy: 70. The return journey is 50 *yojanas*.

Now, the *trairāśika* for the second ⟨person⟩:

$\frac{1}{1}$ day	$\frac{1}{1}$ *yojanas*	$\frac{20}{1}$ days

Result: $\frac{20}{1}$ *yojanas*.

III 19 (10^r)

Sūtra ⟨25⟩.

> Having subtracted the cast-out ⟨fraction⟩ from unity every time ⟨the metal is⟩ smelted, and multiplied ⟨the remainders mutually⟩, one should point out the result of the multiplication ⟨of the product just obtained⟩ by the original quantity as the residue ⟨of the smelting⟩.

Example ⟨1 for Sūtra 25⟩.

> ⟨A certain metal⟩ becomes pure when it is smelted three times, one third being burnt out as dross ⟨each time⟩. The given ⟨metal⟩ is one hundred and eight ⟨units in weight⟩. What is the ⟨weight of the⟩ residue? Tell ⟨me⟩, O learned one!

$\frac{108}{1}$	1	1	1
	$-\frac{1}{3}$	$-\frac{1}{3}$	$-\frac{1}{3}$

'Having subtracted the cast-out ⟨fraction⟩ from unity' ⟨Sūtra 25⟩. The result is 32, ⟨which is⟩ the residue ⟨of the smelting⟩.

At the first smelting, the loss is 36, and the residue 72; at the second smelting, the loss is 24, and the residue 48; and at the third smelting, the loss is 16, and the residue 32.

A verification is made. Statement:

$\frac{0}{1}$	1	1	1	: divisor, remainder 32
	$-\frac{1}{3}$	$-\frac{1}{3}$	$-\frac{1}{3}$	

The result is the original quantity, 108.

Now, the computation of the fifth class is made. ...

$\frac{108}{1}$
$-\frac{1}{3}$
$-\frac{1}{3}$
$-\frac{1}{3}$

The result is 32.

III 20 (10^v)

Again, another ⟨verification⟩:

$\frac{0}{1}$	: divisor, residue 32
$-\frac{1}{3}$	
$-\frac{1}{3}$	
$-\frac{1}{3}$	

The result is the original, 108.

In another verification, a *trairāśika* is made: if the residue, one, is obtained by means of three plus three eighths, then what is obtained by means of one hundred and eight?

$\frac{27}{8}$	$\frac{1}{1}$	$\frac{108}{1}$	result: residue 32

. . . : if ⟨the original⟩ of ⟨the residue⟩, one, is three and three eighths, then what is ⟨the original⟩ of ⟨the residue⟩, thirty-two?

$\frac{1}{1}$	3 $\frac{3}{8}$	$\frac{32}{1}$	result: $\frac{108}{1}$ [14]

Example ⟨2 for Sūtra 25⟩.

> When a piece of iron is smelted once, three tenths of it are lost. What is the residue of ⟨the original quantity⟩, twice seventy? Tell ⟨me⟩, O learned one!

$\frac{3}{10}$	$\frac{140}{1}$

'Having subtracted the cast-out ⟨fraction⟩ from unity' ⟨Sūtra 25⟩. There, unity: 1. When one has subtractetd the $\frac{3}{10}$ ⟨from that⟩, the remainder, $\frac{7}{10}$, is produced. The original quantity is $\frac{140}{1}$. Multiplied by this, it becomes 98. The loss is 42, so that ⟨the sum is⟩ 140.

Verification by means of the *trairāśika*:

$\frac{7}{10}$	$\frac{1}{1}$	$\frac{98}{1}$

Result: 140.

14 The manuscript reads '32' for '$\frac{32}{1}$.'

III 21 (11^r)

Another verification:

$\frac{0}{1}$	: divisor, residue 98
1	
$-\ \frac{3}{10}$	

The result is the original quantity, 140.

Example ⟨3 for Sūtra 25⟩.

When one and a half *palas* ⟨of a certain thing⟩ are purchased, one third of a *pala* goes in loss. When eighteen *palas* are purchased, let the residue be told. Tell ⟨me the answer⟩.

$\frac{1}{3}$	$\frac{18}{1}$
$\frac{3}{2}$: divisor	

Computation. One and a half *palas* are made into a divisor ⟨as shown above⟩; ⟨the result of the division is⟩ this: $\frac{2}{9}$. 'Having subtracted ⟨the cast-out fraction⟩ from unity' ⟨Sūtra 25⟩. Unity: 1. When one has subtracted, the result is: $\frac{7}{9}$ | $\frac{18}{1}$ Multiplied; the result is 14 ⟨*palas*, which are the residue⟩. The loss is 4 ⟨*palas*⟩.

Verification by means of the *trairāśika*.

When one and a half *palas* are purchased, one third ⟨of a *pala*⟩ goes in loss. Eighteen *palas* are purchased. What is the loss? Tell ⟨me⟩, O learned one!

1	$\frac{1}{3}$	$\frac{18}{1}$	result: $\frac{4}{1}$
$\frac{1}{2}$			

Again, ⟨another *trairāśika*:⟩ if one and a half are ⟨required⟩ for ⟨the loss⟩, one third, then what is ⟨required⟩ for four?

$\frac{1}{3}$	1	$\frac{4}{1}$	result: $\frac{18}{1}$
	$\frac{1}{2}$		

Example ⟨4 for Sūtra 25⟩.

When five hundred ⟨*palas*⟩ of gold are smelted four times, one fourth being burnt out as dross ⟨each time⟩, what is the residue? Tell ⟨me⟩, O learned one!

III 22 (11^v)

Verification is made.

$\frac{500}{1}$
$-\frac{1}{4}$
$-\frac{1}{4}$
$-\frac{1}{4}$
$-\frac{1}{4}$

The result is the residue, 158 ⟨*palas*⟩, 1 *tola*, and the remainder $\frac{1}{64}$.

Now, ⟨another⟩ verification is made.

$\frac{0}{1}$	: divisor, residue	$\frac{158}{1}$
$-\frac{1}{4}$		1
$-\frac{1}{4}$		5
$-\frac{1}{4}$		$\frac{1}{64}$
$-\frac{1}{4}$		

The result is the original quantity, 500 ⟨*palas*⟩.

Again, ⟨a verification is made in⟩ the order of the tabular expression ⟨of the Statement⟩.

$\frac{500}{1}$	1	1	1	1
	$-\frac{1}{4}$	$-\frac{1}{4}$	$-\frac{1}{4}$	$-\frac{1}{4}$

The result is the residue, ⟨which⟩ is set up thus: residue, 158 ⟨*palas*⟩, 1 *tola*, and the remainder $\frac{1}{64}$.

Another, fourth, verification is made.

$\frac{0}{1}$	1	1	1	1	: divisor, residue	158
	$-\frac{1}{4}$	$-\frac{1}{4}$	$-\frac{1}{4}$	$-\frac{1}{4}$		1
						5
						$\frac{1}{64}$

The result is 500 ⟨*palas*⟩.

Another ⟨verification⟩. ⟨At the first smelting⟩, the loss is 125 ⟨*palas*⟩, and the residue 375 ⟨*palas*⟩; at the second, the loss is 93 ⟨*palas*⟩, 3 *tolas*, and 9 *māṣas*, and the residue $281\frac{1}{4}$ ⟨*palas*⟩; ⟨at the third⟩, the loss is $70\frac{5}{16}$ ⟨*palas*⟩, and the residue $210\frac{15}{16}$ ⟨*palas*⟩; ⟨at the fourth⟩, the loss is $52\frac{47}{64}$ ⟨*palas*⟩, and the residue $158\frac{13}{64}$ ⟨*palas*⟩. This ⟨method of verification⟩ can be applied everywhere.

III 23 (12^r)

Example ⟨*5 for Sūtra 25*⟩.

... four *prasthas* ... of honey and of water ...

1	1	1	1	$\frac{4}{1}$
$-\frac{1}{4}$	$-\frac{1}{4}$	$-\frac{1}{4}$	$-\frac{1}{4}$	

'Having subtracted the cast-out ⟨fraction⟩ from unity,' says ⟨Sūtra 25⟩. This says: 'subtracted the cast-out.' There, the subtraction is made from unity. ⟨That is, from unity, each cast-out fraction⟩ is to be subtracted. The remainders are:

$\frac{3}{4}$	$\frac{3}{4}$	$\frac{3}{4}$	$\frac{3}{4}$	$\frac{4}{1}$

He would drink one *prastha* every time he has accomplished ⟨the distance of⟩ one *gadyūti*. Four *gadyūtis* are one *yojana*, and four *prasthas* are one *āḍhaka*. Then, 'from multiplication ⟨made⟩ every time ⟨the metal is⟩ smelted' ⟨Sūtra 25⟩:[15] $\frac{81}{256}$. The ⟨word⟩ *āvṛtti* is ⟨a synonym of⟩ *pravṛtti* ('the original quantity').[16] ⟨In the present case, it is⟩ 4.[17] Multiplied by this, it becomes $\frac{81}{64}$. This is the ⟨remaining⟩ portion of honey. The division being made, the quotient is the ⟨remaining⟩ honey: 1 *prastha*, 1 *kuḍava*, and the remainder $\frac{1}{16}$. The portion of water is: 2 *prasthas*, 2 *kuḍavas*, and the remainder $\frac{15}{16}$. Thus, ⟨the sum is⟩ 4 ⟨*prasthas*⟩.

Verification by means of ⟨step-by-step computation according to the process of⟩ drinking and adding. Sixteen *kuḍavas* are one *āḍhaka*: 16. From this, honey ... The remainder is: 12 ⟨*kuḍavas* of honey⟩ and 4 ⟨*kuḍavas* of water⟩. ...

III 24 (12^v)

... : 16. This is ... ⟨The number of⟩ *kuḍavas* in a *prastha* is 4. ⟨Therefore, the quantity of honey drunk is(?)⟩ 3. Out of the remainder, four *kuḍavas* ⟨are to be drunk; the quantities of honey and water contained in the four *kuḍavas* are respectively⟩:

2	2
$\frac{1}{4}$	$-\frac{1}{4}$

⟨This is because⟩ 'four *kuḍavas* are drunk out of the remainder' ⟨Example 5⟩. ⟨Thus, the remaining⟩ honey ⟨and water after dilution are respectively⟩:

7	9
$-\frac{1}{4}$	$\frac{1}{4}$

Further, four *kuḍavas* are drunk. The remaining ⟨quantities⟩ are: $\frac{81}{16}$ and $\frac{175}{16}$. ⟨The latter is⟩ the portion of water. ⟨Thus, the quantity of⟩ honey is $\frac{5}{1}$ *kuḍavas* ⟨and the remainder $\frac{1}{16}$⟩; and ⟨that of⟩ water $\frac{10}{1}$ *kuḍavas* and the remainder $\frac{15}{16}$. Thus, ⟨the sum is⟩ 16 *kuḍavas*.

Example ⟨6 for Sūtra 25⟩.

> Eight ⟨weight units⟩ of saffron are brought in by paying one fourth ⟨of the quantity⟩ as a toll ⟨at each toll-station⟩. If there are four toll-stations, what is the residue? Tell ⟨me⟩, O learned one!

$\frac{8}{1}$	1
	$-\frac{1}{4}$

15 The citation is corrupt.
16 An unusual meaning of *āvṛtti*.
17 Literally, '4 is produced by multiplication.'

Computation. 'Having subtracted the cast-out ⟨fraction⟩ from unity' ⟨Sūtra 25⟩. Cast-out: $\begin{array}{|c|c|} \frac{8}{1} & \frac{3}{4} \\ \hline \end{array}$ Multiplied; the result is 6. As a toll, 2 ⟨units are paid⟩. The result is: $\begin{array}{|c|c|} \frac{6}{1} & 1 \\ & -\frac{1}{4} \\ \hline \end{array}$ Multiplied by this ⟨latter, the former⟩ becomes: $\begin{array}{|c|} 4 \\ \frac{1}{2} \\ \hline \end{array}$ The loss is: $\begin{array}{|c|} 1 \\ \frac{1}{2} \\ \hline \end{array}$ 'By paying ⟨one fourth⟩,' $\begin{array}{|c|} 1 \\ -\frac{1}{4} \\ \hline \end{array}$ out of the residue, $\begin{array}{|c|} 4 \\ \frac{1}{2} \\ \hline \end{array}$ Multiplied; the result is $\frac{27}{8}$. . . .

III 25 (13^r)

. . .

A verification is made.

$$\begin{array}{|c|c|c|c|c|} \frac{8}{1} & 1 & 1 & 1 & 1 \\ & -\frac{1}{4} & -\frac{1}{4} & -\frac{1}{4} & -\frac{1}{4} \\ \hline \end{array}$$

Multiplied; the result is $\frac{81}{32}$.

Again, another ⟨verification⟩:

$$\begin{array}{|c|c|c|c|c|} \frac{8}{1} & \frac{3}{4} & \frac{3}{4} & \frac{3}{4} & \frac{3}{4} \\ \hline \end{array}$$

The result is $\frac{81}{32}$, the answer ⟨to the problem⟩.

Again, another ⟨verification⟩:

$$\begin{array}{|c|} \frac{8}{1} \\ -\frac{1}{4} \\ -\frac{1}{4} \\ -\frac{1}{4} \\ -\frac{1}{4} \\ \hline \end{array}$$

Result: $\frac{81}{32}$.

Further, a verification:

$$\begin{array}{|c|l|} \frac{0}{1} & \text{: divisor, residue } \frac{81}{32} \\ \cline{2-2} -\frac{1}{4} & \\ -\frac{1}{4} & \\ -\frac{1}{4} & \\ -\frac{1}{4} & \\ \cline{1-1} \end{array}$$

Result: 8 ⟨units⟩ of saffron.

Example ⟨*7 for Sūtra 25*⟩.

> There are eight *bhārakas* of molasses. When one third, one sixth, and one fifth are given away ⟨in order out of the successive residues⟩, what will be the ⟨final⟩ residue?

$\frac{8}{1}$	$\frac{2}{3}$	$\frac{5}{6}$	$\frac{4}{5}$

Multiplied; the result is $\frac{32}{9}$ ⟨*bhārakas*⟩. This is the answer.

Example ⟨*8 for Sūtra 25*⟩.

> When ten *droṇas* ⟨of seeds⟩ are invested at the harvest-rate of five to four, what is the harvest after three seasons? Let it be told, O best of mathematicians!

$\frac{10}{1}$	$\frac{5}{4}$	$\frac{5}{4}$	$\frac{5}{4}$

Multiplied; the result is $\frac{1250}{64}$ ⟨*droṇas*⟩.

III 26 (13^v)

...

⟨Verification⟩:

$\frac{10}{1}$
$\frac{1}{4}$
$\frac{1}{4}$
$\frac{1}{4}$

Result: 19 *droṇas*, 2 *āḍhakas*, 0 *prastha*, and 2 *kuḍavas*.

Another ⟨verification⟩:

$\frac{0}{1}$	: divisor, gains	$\frac{19}{1}$ *droṇas*
$\frac{1}{4}$		2 *āḍhakas*
		4 ⟨*āḍhakas* in⟩ one *droṇa*
$\frac{1}{4}$		0 *prasthas*
		4 *prasthas* in one *āḍhaka*
$\frac{1}{4}$		2 *kuḍavas*
		4 *kuḍavas* in one *prastha*

The result is $\frac{10}{1}$ ⟨*droṇas*⟩.

Example ⟨9 for Sūtra 25⟩.

Sixty ⟨monetary units⟩ of a certain merchant are decreased by their own half, increased by one third ⟨of the result⟩, decreased by its own quarter, and increased by one fifth ⟨of the result⟩. Thus, ⟨his property⟩ has been increased twice, ⟨and decreased twice⟩. What is the increase reached ⟨finally⟩ in the trade? Or what is the residue? Let it be told.

$\frac{60}{1}$	1	1	1	1
	$-\frac{1}{2}$	$\frac{1}{3}$	$-\frac{1}{4}$	$\frac{1}{5}$

Through ⟨the process of⟩ gaining and losing money ⟨described in the problem⟩,[18] the result is 36.
Further, a verification of this ⟨answer is made thus⟩:

$\frac{0}{1}$	1	1	1	1	: divisor	$\frac{36}{1}$
	$-\frac{1}{2}$	$\frac{1}{3}$	$-\frac{1}{4}$	$\frac{1}{5}$		

Result: 60.

Again, another verification:

$\frac{60}{1}$
$-\frac{1}{2}$
$\frac{1}{3}$
$-\frac{1}{4}$
$\frac{1}{5}$

Result: 36.

Again, another ⟨verification⟩. The original quantity of this ⟨last Statement⟩ is ⟨here supposed to be⟩ unknown.

$\frac{0}{1}$	⟨: divisor, residue 36⟩[19]
$-\frac{1}{2}$	
$\frac{1}{3}$	
$-\frac{1}{4}$	
$\frac{1}{5}$	

Result: 60.

III 27 (14^r)

⟨*Example 10 for Sūtra 25.*⟩

... Tell ⟨me⟩ what is made of that whose value is(?) ... Tell me that correctly.

18 Or, 'Through additions to, and subtractions from, unity, ⟨of the fractions⟩.'

19 The portion in the angle brackets has been omitted by the scribe, probably because there was no room for it.

$\frac{1}{3}$	$\frac{1}{4}$	$\frac{1}{5}$	The sum of the taxes taken away: 24.

Computation. 'Having subtracted the cast-out from unity' ⟨Sūtra 25⟩.

$\frac{2}{3}$	$\frac{3}{4}$	$\frac{4}{5}$

When one has multiplied the results ⟨mutually⟩, the result is $\frac{2}{5}$. This much is again subtracted from unity; the result is $\frac{3}{5}$. When one has divided the sum of the taxes by this, ⟨that is, when the former has been⟩ multiplied ⟨by the latter's reciprocal⟩, the result is 40. This is the ⟨original⟩ sum.

Verification. $\frac{2}{5}$ $\frac{40}{1}$ Multiplied; the result is 16. ⟨This is⟩ the residue, ⟨while the loss is⟩ 24; added up: 40.

Another verification of that ⟨answer⟩:

$\frac{40}{1}$	The result is 16, ⟨the residue⟩. The loss is 24.
$-\frac{1}{3}$	Thus, ⟨the sum is⟩ 40.
$-\frac{1}{4}$	
$-\frac{1}{5}$	

Example ⟨11 for Sūtra 25⟩.

By four ... equal to the known quantity of molasses(?) ... molasses. Forty ⟨weight units⟩ are visible ⟨as the total increase obtained⟩ by increasing ⟨the molasses⟩ by one third, one fourth, one fifth, and one sixth.[20]

III 28 (14^v)

... | □ / $\frac{□}{3}$ | ...

Example ⟨12 for Sūtra 25⟩.

The residue from a piece of iron stone, ⟨whose weight is⟩ unknown, is observed to be twenty-seven, after it has been smelted three times, the loss being one third, one fourth, and one fifth. What is the total? Tell ⟨me⟩, O truth-knower! Let the loss be also told to me.

$\frac{1}{3}$	$\frac{1}{4}$	$\frac{1}{5}$	remainder $\frac{27}{1}$

Computation. 'Having subtracted the cast-out from unity' ⟨Sūtra 25⟩.

$\frac{2}{3}$	$\frac{3}{4}$	$\frac{4}{5}$

20 Literally, 'by three, four, five, and six.'

Multiplied; the result is $\frac{2}{5}$. Subtraction ⟨of this⟩ from unity: $\frac{3}{5}$. By this is divided the remainder. The remainder is 27. Divided; the result is 45. Out of this, twenty-seven should be thrown away; the result is 18. This is the loss.

Example ⟨13 for Sūtra 25⟩.

> A piece of waste iron is smelted three times, ⟨the loss⟩ at the last step being one fifth. The original quantity is not known; the residue is not seen either. The sum of the original and the residue is, ⟨however, known to be⟩ only twenty. What would be the unknown original? Or what is the residue? Tell me.

$\frac{1}{3}$	$\frac{1}{4}$	$\frac{1}{5}$

⟨The sum of the original and the residue: 20.⟩

'Having subtracted the cast-out from unity' ⟨Sūtra 25⟩. . . .

III 29 (15[r])

⟨*Example 14 for Sūtra 25.*⟩

> . . . of the loss; and the original quantity . . . the loss. Let it be told by anyone who can. This is my doubt. O wise man! ⟨My⟩ investigations are upon the quality of what has been smelted.

$\frac{2}{3}$	$\frac{3}{4}$	$\frac{4}{5}$

Remainder after the reduction: $\frac{32}{1}$.

Computation. 'Having multiplied ⟨those⟩ smelted.'[21] ⟨The fractions are mutually⟩ multiplied; the result is ⟨$\frac{2}{5}$. This is again subtracted from unity; the result is⟩ $\frac{3}{5}$. One should add unity: $\frac{8}{5}$. When the division ⟨of 32 by $\frac{8}{5}$⟩ is made, the quotient ⟨is to be taken⟩. Thus, when one has divided, the result is

$\frac{5}{8}$	$\frac{32}{1}$

The result ⟨of the multiplication⟩ is 20. This is that original quantity ⟨which is questioned⟩. The rest is 12. In total, 32.

⟨The end of⟩ the twenty-fifth *sūtra*: 25.

III 30 (15[v])

⟨*Example 1 for Sūtra 26.*⟩

> . . . O friend! What would be the original quantity?

$\frac{1}{3}$	$\frac{1}{3}$	$\frac{1}{3}$	$\frac{1}{3}$	residue $\frac{16}{1}$

Computation. 'Every time ⟨the metal is⟩ smelted, and multiplied. By ịt.' ⟨Sūtra 26⟩. 'Having subtracted ⟨the cast-out fraction⟩ from unity' ⟨Sūtra 26⟩. The result is:

---

21 This, though corrupted, must be a citation from Sūtra 25.

$\frac{2}{3}$	$\frac{2}{3}$	$\frac{2}{3}$	$\frac{2}{3}$

Multiplied: $\frac{16}{81}$. Divided: $\frac{81}{16}$. One should multiply ⟨this⟩ by the residue. The residue is $\frac{16}{1}$. Multiplied, it becomes $\frac{81}{1}$. This is intended to be the original quantity.

Now, another rule[22] by means of the reduction of fractions to the same color[23]:

> Eighty-one ⟨*palas*⟩ of iron, ⟨to be smelted four times⟩, have been given. What is the residue? Tell ⟨me⟩, O righteous man, if hard study in mathematics has been done ⟨by you⟩.

$\frac{81}{1}$	1	1	1	1
	$-\frac{1}{3}$	$-\frac{1}{3}$	$-\frac{1}{3}$	$-\frac{1}{3}$

The result is 16 ⟨*palas*⟩, the residue.

Again, a verification is made. The original quantity is ⟨here supposed to be⟩ unknown.

$\frac{0}{1}$	1	1	1	1	: divisor, residue $\frac{16}{1}$
	$-\frac{1}{3}$	$-\frac{1}{3}$	$-\frac{1}{3}$	$-\frac{1}{3}$	

The result is 81 *palas* of iron.

III 31 (16^r)

⟨*Example 2 for Sūtra 26*⟩.

...

1 : divisor, $\frac{1}{3}$ $\frac{1}{2}$	residue $\frac{10}{1}$

Computation. ⟨The second term in the first cell is⟩ dvided ⟨by the first term⟩; the result is:

$\frac{2}{9}$	residue $\frac{10}{1}$

'Every time ⟨the metal is⟩ smelted, and multiplied' ⟨Sūtra 26⟩. When one has subtracted ⟨the $\frac{2}{9}$⟩ from unity, ⟨the result is⟩ divided; $\frac{9}{7}$. Multiplied by this, ⟨the $\frac{10}{1}$⟩ becomes $\frac{90}{7}$. The division being made, the quotient is 12, and the remainder $\frac{6}{7}$.

Verification of this ⟨answer⟩ by means of the *trairāśika*:

$\frac{7}{6}$	1 $\frac{1}{2}$	$\frac{10}{1}$	result: 12 $\frac{6}{7}$

22 *vidhi*. 'Computation'? Actually, this is a verification.

23 *kalāsavarṇa*

Example ⟨3 for Sūtra 26⟩.

A pitcher of honey was increased by its two thirds; in the second place two fifths were taken away by tax officers; in the third place it was increased by two sevenths; and in the fourth place two ninths were taken away by tax officers. Thus, the result was three *palas* ⟨of honey⟩. What was the original quantity? Tell ⟨me⟩, O learned one!

$\frac{2}{3}$	⟨-⟩$\frac{2}{5}$	$\frac{2}{7}$	⟨-⟩$\frac{2}{9}$	residue $\frac{3}{1}$

'Every time ⟨the metal is⟩ smelted, ⟨the fraction is⟩ added to, or subtracted from, ⟨unity⟩' ⟨Sūtra 26?⟩. When one has ... unity ...

III 32 (16^v)

...

⟨The end of⟩ the twenty-sixth *sūtra*: 26.

I will next expound the impurity of gold, for which this is a *sūtra*.

⟨*Sūtra 27.*⟩

Having multiplied ⟨the weights of⟩ the gold pieces by ⟨their own⟩ impurities, one should then divide their sum by ⟨the weights of⟩ the gold pieces added together. This ⟨result⟩ is indeed the loss ⟨of gold⟩ per unit ⟨weight⟩ (i.e., impurity) ⟨of the alloy⟩.

Example ⟨1 for Sūtra 27⟩.

⟨Four⟩ gold pieces, the quantities of which are one, two, three, and four *suvarṇas* ⟨respectively⟩, are inferior by one, two, three, and four negative *māṣakas* ⟨per *suvarṇa* in order⟩. ⟨They are melted into⟩ one having a single lustre. ⟨What is the impurity of the alloy?⟩

Statement of those ⟨given numbers⟩ is made.

−1	−2	−3	−4	⟨impurity in *māṣas*⟩
1	2	3	4	⟨weight in *suvarṇas*⟩

Computation. 'Having multiplied ⟨the weights of⟩ the gold pieces by ⟨their own⟩ impurities,' says ⟨Sūtra 27⟩. When one has multiplied ⟨each weight⟩ by ⟨its own⟩ impurity, the result is: 1, 4, 9, and 16. ... Their sum is 30. The sum of ⟨the weights of⟩ the gold pieces is 10. When one has divided ⟨the 30⟩ by this, the quotient is 3. ⟨This is the impurity of the alloy.⟩

III 33 (17^r)

Verification by means of the *trairāśika*:

$\frac{10}{1}$	$\frac{30}{1}$	$\frac{1}{1}$	result: $\frac{3}{1}$ *māṣas*
$\frac{10}{1}$	$\frac{30}{1}$	$\frac{2}{1}$	result: $\frac{6}{1}$ *māṣas*
$\frac{10}{1}$	$\frac{30}{1}$	$\frac{3}{1}$	result: $\frac{9}{1}$ *māṣas*
$\frac{10}{1}$	$\frac{30}{1}$	$\frac{4}{1}$	result: $\frac{12}{1}$ *māṣas*

...

Example ⟨2 for Sūtra 27⟩.

There are ⟨four⟩ gold pieces, the quantities of which are one, two, three, and four *suvarṇas* ⟨respectively⟩. They are inferior by one half, one third, one fourth, and one fifth of a *māṣaka* ⟨per *suvarṇa* in order⟩. What is the impurity ⟨of the alloy made from them⟩?

1	2	3	4	⟨weight in *suvarṇas*⟩
⟨-⟩ $\frac{1}{2}$	⟨-⟩ $\frac{1}{3}$	⟨-⟩ $\frac{1}{4}$	⟨-⟩ $\frac{1}{5}$	⟨impurity in *māṣas*⟩

Computation. 'Having multiplied ⟨the weights of⟩ the gold pieces by ⟨their own⟩ impurities' ⟨Sūtra 27⟩. ⟨The result of⟩ this ⟨computation⟩ is set up:

$\frac{1}{2}$	$\frac{2}{3}$	$\frac{3}{4}$	$\frac{4}{5}$

'One should then divide their sum' ⟨Sūtra 27⟩. Reduction to the same denominator having been made, ⟨the fractions are⟩ added together: $\frac{163}{60}$. When one has divided ⟨this⟩ 'by ⟨the weights of⟩ the gold pieces added together' — ⟨the sum of the weights of⟩ the gold ⟨pieces⟩ in the present case is 10 — when one has divided ⟨the $\frac{163}{60}$⟩ by this, the result is $\frac{163}{600}$. This is the loss ⟨of gold⟩ per *suvarṇa*.

A verification should be made by means of the *trairāśika*.

III 34 (17^v)

$\frac{10}{1}$	$\frac{163}{60}$	$\frac{1}{1}$	result: $\frac{163}{600}$ *māṣas*
$\frac{10}{1}$	$\frac{163}{60}$	$\frac{2}{1}$	result: $\frac{163}{300}$ *māṣas*
$\frac{10}{1}$	$\frac{163}{60}$	$\frac{3}{1}$	result: $\frac{163}{200}$ *māṣas*
$\frac{10}{1}$	$\frac{163}{60}$	$\frac{4}{1}$	result: $\frac{163}{150}$ *māṣas*

⟨The last terms are⟩ added together; the result is $\frac{1630}{600}$ *māṣas*, to be reduced to $\frac{163}{60}$ ⟨*māṣas*⟩.

Example ⟨3 for Sūtra 27⟩.

Listen to me. There are ⟨nine⟩ gold pieces, the quantities of which are ⟨severally⟩ one, two, three, four, five, six, seven, eight, and nine *suvarṇas*. ⟨Their⟩ impurities begin with two *māṣas* and decreases one by one in order. When you have mixed up those gold pieces into one, let ⟨the impurity of the alloy⟩ be told. O best of calculator!

1	2	3	4	5	6	7	8	9	⟨*suvarṇas*⟩
−2	−3	−4	−5	−6	−7	−8	−9	−10	⟨*māṣas*⟩

'Having multiplied by the impurities' ⟨Sūtra 27⟩. The result is: 2, 6, 12, 20, 30, 42, 56, 72, and 90. The sum of these is 330. The sum of ⟨the weights of⟩ the gold pieces is 45. When one has divided ⟨the 330⟩ by this, the quotient is $\frac{330}{45}$. One fifteenth part ⟨of the numerator as well as of the denominator⟩ being taken, $\frac{22}{3}$, the quotient is 7, and the reaminder $\frac{1}{3}$. This is the loss ⟨of gold⟩ in *māṣas* per one ⟨*suvarṇa*⟩.

In a verifiaction, a *trairāśika* is made.

$\frac{45}{1}$	$\frac{330}{1}$	$\frac{1}{1}$	result: $\frac{22}{3}$

Verification should be made in the same way for all ⟨gold pieces⟩.

III 35 (18r)

⟨The end of⟩ the twenty-seventh *sūtra*: 27.

Sūtra ⟨28⟩.

⟨The weight of⟩ the alloy is multiplied by ⟨its own⟩ impurity. ⟨From the result are⟩ subtracted ⟨the weights of⟩ the gold pieces multiplied by ⟨their respective impurities in⟩ *māṣakas*. When ⟨the remainder is divided⟩ by ⟨the weight of⟩ the gold piece ⟨whose impurity is unknown⟩, the quotient is the unknown *māṣakas* for the impurity.

Example ⟨1 for Sūtra 28⟩.

⟨A gold piece of⟩ one ⟨*suvarṇa*⟩ is accomplished (i.e., becomes pure) by two *māṣas*. ⟨Another gold piece of⟩ two ⟨*suvarṇas*⟩ is accomplished by five *māṣas*. By how many ⟨*māṣas*⟩ is ⟨another gold piece of⟩ three ⟨*suvarṇas*⟩ accomplished? They are, ⟨in total⟩, only six ⟨*suvarṇas* in weight⟩. O friend! Having observed that the alloy is inferior by four *māṣakas*, you shall obtain — by how many ⟨*māṣas*⟩ is the gold piece of three *suvarṇas* accomplished? Tell ⟨me⟩ the ⟨number of⟩ *māṣakas*.

1	2	3	6	⟨weight in *suvarṇas*⟩
−2	−5	0	−4	⟨impurity in *māṣas*⟩

Computation. '⟨The weight of⟩ the alloy is multiplied by ⟨its own⟩ impurity,' says ⟨Sūtra 28⟩. When one has multiplied ⟨the weight of⟩ the alloy, $\frac{6}{1}$, ⟨by its own impurity⟩, four, 4, the result is 24. '⟨The weights of⟩ the gold pieces ⟨multiplied by their respective impurities are⟩ subtracted from that.'[24] When one has multiplied one by two, and two by five, the results are: 2 and $\frac{10}{1}$. Their sum is 12. When one has subtracted, ..., when one has subtracted, the resulting remainder is 12. 'By ⟨the weight of⟩ the alloy which is impure(?)[24] ...

24 Apparently, these phrases are cited from a different *sūtra*.

III 36 (18^v)

⟨The end of⟩ the twenty-eighth *sūtra*: 28.

Sūtra ⟨29⟩.

Having multiplied ⟨the weights of⟩ the gold pieces by ⟨their respective⟩ impurities, one should subtract their sum from the product of the ⟨pure⟩ gold and ⟨the weights of⟩ the gold pieces ⟨added together⟩. He should ⟨then⟩ divide the remaining quantity by the ⟨pure⟩ gold less the impurity in *māṣas* of the alloy. He should point out the quotient as the quantity of the alloy.

Example ⟨1 for Sūtra 29⟩.

⟨There are four gold pieces, of which⟩ the quantities are one, two, three, and four ⟨*suvarṇas* respectively, and of which⟩ the impurities are one, two, three, and four *māṣakas* ⟨in order⟩. They are said to be melted into one[25] ⟨together with a piece of base metal⟩. The alloy, which contains the unknown metal, is inferior by eleven *māṣakas*. O learned one! Calculate the quantity ⟨of the alloy⟩ by using the ⟨given⟩ impurities and the known ⟨weights of the⟩ gold pieces.

1	2	3	4	0	⟨*suvarṇas*⟩
⟨-⟩1	⟨-⟩2	⟨-⟩3	⟨-⟩4	⟨-⟩11	⟨*māṣas*⟩

Computation. 'Having multiplied ⟨the weights of⟩ the gold pieces by ⟨their respective⟩ impurities,' says ⟨Sūtra 29⟩. . . .

25 Literally, 'turned round (*āvartita*) in one place.'

IV 1 (21^r)

⟨*Example 1 for Sūtra N7.*⟩

... one *rūpa* evey one third of a day, one *rūpa* every half of a day, and three *rūpas* every five days. In how many days ⟨are one hundred *rūpas*⟩ given to them?

$\frac{1}{1}$ *rūpa*	$\frac{1}{1}$ *rūpa*	$\frac{3}{1}$ *rūpa*	visible $\frac{100}{1}$
$\frac{1}{3}$ day	$\frac{1}{2}$ day	$\frac{5}{1}$ days	

Computation. When one has made the reciprocals ⟨of the divisors, and multiplied the results by their respective dividends⟩,

$\frac{3}{1}$	$\frac{2}{1}$	$\frac{3}{5}$	visible $\frac{100}{1}$

'By the sum of the shares' ⟨Sūtra N7⟩. The sum of the shares, $\frac{28}{5}$, is divided, $\frac{5}{28}$, and multiplied by the visible. ...

21^rF[1]: ... to a poet ...
21^rF[2]: ... five ... $\frac{1}{3}$ ...
21^rF[3]: ... *Example.* One *rūpa* ...

IV 2 (21^v)

⟨*Example 2 for Sūtra N7.*⟩

... The means of livelihood of the third ⟨person⟩ is half of nine ⟨*dīnāras* every one and a quarter days⟩. Five hundred *dīnāras* are given to them ⟨in total⟩. What is for each?

2 *dīnāras* $\frac{1}{2}$	3 *dīnāras* $\frac{1}{2}$	4 *dīnāras* $\frac{1}{2}$	visible $\frac{500}{1}$
1 days $\frac{1}{2}$	1 days $\frac{1}{3}$	1 days $\frac{1}{4}$	

The reciprocal ⟨of each divisor⟩ is made.

$\frac{10}{6}$	$\frac{21}{8}$	$\frac{36}{10}$	visible $\frac{500}{1}$

'By the sum of the shares' ⟨Sūtra N7⟩. ...

21^vF[1]: result: 1□ ...
21^vF[2]: □5. Whose(?) ...
21^vF[3]: ... is made.
21^vF[4]: ... | ... 3 *dīnāras* | 5 days | 7 ...

IV 3 (22^r)

$\frac{100000}{947}$	$\frac{157500}{947}$	$\frac{216000}{947}$

The sum of these is taken; the result ... is $\frac{473500}{947}$. Reduced; the result produced is 500 *dīnāras*.

A verification of this ⟨solution is made⟩ by means of the *trairāśika*.

2 *dīnāras* $\frac{1}{2}$	1 days $\frac{1}{2}$	$\frac{100000}{947}$ ⟨*dīnāras*⟩	result: $\frac{60000}{947}$ days
3 *dīnāras* $\frac{1}{2}$	1 days $\frac{1}{3}$	$\frac{157500}{947}$ *dīnāras*	result: $\frac{60000}{947}$ days
4 *dīnāras* $\frac{1}{2}$	1 days $\frac{1}{4}$	$\frac{216000}{947}$ *dīnāras*	result: $\frac{60000}{947}$ days

IV 4 (22^v)

⟨*Example 1 for Sūtra N8.*⟩

... O man of a twice-born class! He gave twice that to the second ⟨person⟩, thrice ⟨the amount given to⟩ the first to the third, and four times ⟨the amount given to⟩ the first to the fourth. The ⟨total⟩ amount given to the four ⟨persons⟩ is one hundred accompanied by two[24]. Tell ⟨me⟩. What was the amount given to the first, and what to each of the others?

$\frac{0}{1}$	$\frac{2}{1}$	$\frac{3}{1}$	$\frac{4}{1}$	visible $\frac{200}{1}$

'Having added unity to zero' ⟨Sūtra N8⟩: 1, 2, 3, 4. By means of the principle of shares, the result is: 20, 40, 60, 80. Thus, ⟨the sum is⟩ 200.

Another rule ⟨for calculating the sum⟩ of these ⟨quantities⟩:

first term $\frac{20}{1}$	common difference $\frac{20}{1}$	period $\frac{4}{1}$

By means of the *Minus-One* method ⟨Sūtra Q2⟩, the sum is 200.

Sūtra ⟨*N9*⟩.

One should put down any optional ⟨number⟩ in ⟨the place of⟩ zero, and then make multiplications. ...

24 *śatam ekaṃ dvayānvayaṃ*. This expression usually denotes 102, but here it stands for 200. See the 'visible' number in the enclosure.

IV 5 (23^r)

⟨*Example 1 for Sūtra N9.*⟩

. . . Thrice . . . is given . . . What would be ⟨the donation⟩ of the first ⟨person⟩?

$\frac{0}{1}$	then $\frac{2}{1}$	then $\frac{3}{1}$	then $\frac{4}{1}$	visible $\frac{132}{1}$

'One should put down any optional ⟨number⟩ in ⟨the place of⟩ zero' ⟨Sūtra N9⟩. In the present case, ⟨we take⟩ the optional ⟨number to be⟩ 1. 'And then make multiplications' ⟨Sūtra N9⟩.

$\frac{1}{1}$	$\frac{2}{1}$	$\frac{2}{1}$ $\frac{3}{1}$	$\frac{6}{1}$ $\frac{4}{1}$

⟨The first term in each cell⟩ is multiplied by the additional term, ⟨if any⟩: 1, 2, 6, 24. Added together: 33. One should divide the visible ⟨by this⟩: $\frac{132}{33}$, ⟨which is⟩, to be reduced; it becomes $\frac{4}{1}$. ⟨This⟩[25] is given by the first ⟨person⟩. Hence the statement: 4, 8, 24, 96. Thus, ⟨the sum is⟩ 132.

This is the arithmetic of multiplicative series. Now, the ⟨arithmetic of⟩ additive-multiplicative ⟨series⟩ is applied.

Sūtra ⟨*N10*⟩.

> Any optional ⟨number⟩ is put down in ⟨the place of⟩ zero, and then, in order, multiplications ⟨are made⟩. . . .

IV 6 (23^v)

⟨*Example 1 for Sūtra N10.*⟩

. . . Having made . . . for the fourth ⟨person⟩ . . . What would be for the first?

$\frac{0}{1}$	$\frac{2}{1}$	$\frac{3}{1}$ $\frac{3}{1}$	$\frac{12}{1}$ $\frac{4}{1}$	visible $\frac{300}{1}$

'Any optional ⟨number⟩ is put down in ⟨the place of⟩ zero' ⟨Sūtra N10⟩. The optional ⟨number is taken to be⟩ 1. This is put down as the first quantity. 'And then, in order, ⟨the terms in each cell are mutually⟩ multiplied' ⟨Sūtra N10⟩:[26] 1, 2, 9, 48. The sum of these is taken: 60. By this is divided the visible:

$\frac{1}{60}$	$\frac{300}{1}$

The result is $\frac{5}{1}$. This is the property of the first ⟨person⟩. By this, one should multiply ⟨each⟩ term: 5, 10, 45, 240. Thus, ⟨the sum is⟩ 300.

This is the arithmetic of additive-multiplicative ⟨series⟩.

Example ⟨*2 for Sūtra N10*⟩.

> I do not know how ⟨much⟩ money is given to the first ⟨person⟩. If that, less half, is given(?) . . .

25 Here, the manuscript has the numerical figures, '15,' in a circle. The circle may have been meant for indicating that the '15' is a corruption of '*eṣa*.'

26 The quotation is not verbatim.

IV 7 (24^r)

⟨*Example 1 for Sūtra N11.*⟩

> ... one hundred, forty-four and a half ... and four times ... was given ... O best of twice-borns! What is the property of the first ⟨person⟩?

Statement:

$\frac{0}{1}$	1	$\frac{2}{1}$	2	$\frac{3}{1}$	3	$\frac{4}{1}$	4	visible	144
	$\frac{1}{2}$		$\frac{1}{2}$		$\frac{1}{2}$		$\frac{1}{2}$		$\frac{1}{2}$

'One should put down any optional ⟨number⟩ in ⟨the place of⟩ zero' ⟨Sūtra N11⟩. The optional ⟨number is here taken to be⟩ $\frac{1}{1}$. 'Addition and then multiplication' ⟨Sūtra N11⟩. When one has made addition and multiplication — one should make multiplication — $\frac{5}{2}$ is multiplied by two. 'One should multiply the upper by the upper, and the lower by the lower' ⟨Sūtra Q7⟩: $\frac{10}{2}$. Increased by two and a half: $\frac{15}{2}$. Multiplication by the third number: three by seven and a half. ⟨The result is⟩ $\frac{45}{2}$. Increased by three and a half: $\frac{52}{2}$. One should multiply the fourth number by twenty-six; the result is $\frac{208}{2}$. Increased by four and a half, it becomes $\frac{217}{2}$. The visible is divided by their sum, $\frac{289}{2}$; the result is 1. ⟨This is the property of the first. Hence⟩, every ⟨term⟩ remains the same.

IV 8 (24^v)

⟨*Example 1 for Sūtra N12.*⟩

> ... By the third ⟨person⟩ was given ⟨three times the sum of the first two⟩, increased by three and a half; and four times the sum of those ⟨first three⟩, increased by half of nine, was given by the fourth. In total, two hundred and twenty-two were given. What was here given by the first?

$\frac{0}{1}$	$\frac{3}{2}$	$\frac{2}{1}$	$\frac{5}{2}$	$\frac{3}{1}$	$\frac{7}{2}$	$\frac{4}{1}$	$\frac{9}{2}$	total given 222

'Having put down unity in the place of zero' ⟨Sūtra N12⟩: 1. Through the addition-multiplication-addition process, ⟨the following series⟩ is produced. Statement:

$\frac{5}{2}$	$\frac{15}{2}$	$\frac{67}{2}$	$\frac{357}{2}$	visible $\frac{222}{1}$

By adding up ⟨the four terms⟩, 222 is produced. The visible, 222, is divided ⟨by this⟩; the result is 1. ...

Example ⟨*2 for Sūtra N12*⟩.

> I do not know the first ⟨term, which is a certain number⟩ plus one and a half. Then, twice the first is increased by half of five. The first ...

IV 9 (25^v)

. . .

$\frac{0}{1}$ $\frac{3}{2}$	$\frac{2}{1}$ $\frac{5}{2}$	$\frac{3}{1}$ $\frac{7}{2}$	$\frac{4}{1}$ $\frac{9}{2}$	visible $\frac{71}{2}$

Computation. 'Having put down unity in the place of zero' ⟨Sūtra N12⟩: 1. Increased ⟨by the $\frac{3}{2}$⟩, it becomes $\frac{5}{2}$. ⟨This, when⟩ multiplied by two and increased by half of five, is of the second: $\frac{15}{2}$. For the third, the first is multiplied by three and increased by half of seven; the result is $\frac{22}{2}$. For the fourth, ⟨the first is⟩ multiplied by four and increased by half of nine; the result is $\frac{29}{2}$. Statement in one place:

$\frac{5}{2}$	$\frac{15}{2}$	$\frac{22}{2}$	$\frac{29}{2}$	visible $\frac{71}{2}$

Added up: $\frac{71}{2}$. The visible is divided ⟨by this⟩; the result is 1. Every ⟨term⟩, multiplied by this, remains the same: $\frac{5}{2}$, $\frac{15}{2}$, $\frac{22}{2}$, $\frac{29}{2}$. The sum is $\frac{71}{2}$.

Example ⟨3 for Sūtra N12⟩: this is another rule[27].

> The amount of money given by the first ⟨person⟩ is not known, but ⟨is known to be a certain number⟩ plus one and a half. Then, twice ⟨that⟩, decreased by half of five, was given by the second. Then, thrice ⟨that⟩, decreased by half of seven, was given by the third. Then, four times ⟨that⟩ just obtained, decreased by half of nine, was given by the fourth. In total, twenty and a half were given to one and the same person. What was the amount given by the first? Tell ⟨me⟩.

⟨$\frac{0}{1}$, $\frac{3}{2}$⟩[28]	⟨times⟩ $\frac{2}{1}$, $-\frac{5}{2}$	times $\frac{3}{1}$, $-\frac{7}{2}$	times $\frac{4}{1}$, $-\frac{9}{2}$	visible $\frac{41}{2}$

IV 10 (25^r)

⟨Example 4 for Sūtra N12.⟩

. . .

$\frac{0}{1}$, $\frac{3}{2}$	$\frac{2}{1}$, $-\frac{5}{2}$	$\frac{3}{1}$, $-\frac{7}{2}$	$\frac{4}{1}$, $-\frac{9}{2}$	visible $\frac{78}{1}$

Computation. Unity is put down in ⟨the place of⟩ zero. Increased ⟨by the $\frac{3}{2}$⟩, it becomes $\frac{5}{2}$. Multiplied by the second ⟨number, it becomes⟩ $\frac{10}{2}$. ⟨Half of five⟩ should be subtracted; ⟨the result is⟩ $\frac{5}{2}$. The third ⟨number⟩ is multiplied by the total, ⟨i.e.⟩, by the sum. The sum is $\frac{10}{2}$. Multiplied: $\frac{30}{2}$. ⟨Half of seven⟩ should be subtracted: $\frac{23}{2}$. The sum is $\frac{33}{2}$. Multiplied ⟨by the fourth number⟩: $\frac{132}{2}$. The negative ⟨term, $-\frac{9}{2}$,⟩ is to be subtracted; the rest is $\frac{123}{2}$. Statement of these ⟨results⟩:

$\frac{5}{2}$	$\frac{5}{2}$	$\frac{23}{2}$	$\frac{123}{2}$	visible $\frac{78}{1}$

---

27 *vidhi*. See III 30 for a similar usage of this word.

28 The first cell does not exist on the manuscript.

The sum of these ⟨first four terms⟩ is $\frac{156}{2}$. Divided:

$\frac{2}{156}$	$\frac{78}{1}$

⟨Multiplied⟩; the result is 1.

...

IV 11 (26^r)

⟨*Example 5 for Sūtra N12.*⟩

...

$\frac{0}{1}, \frac{3}{2}$	$\frac{2}{1}, -\frac{5}{2}$	$\frac{3}{1}, -\frac{7}{2}$	$\frac{4}{1}, -\frac{9}{2}$	visible $\frac{29}{2}$

Computation. 'Having put down unity in the place of zero' ⟨Sūtra N12⟩. Increased ⟨by the $\frac{3}{2}$⟩, it becomes $\frac{5}{2}$. The second is twice the first, minus half of five: $\frac{5}{2}$. The third is thrice the first, minus half of seven: $\frac{8}{2}$. The fourth is four times the first, minus half of nine; the remainder is $\frac{11}{2}$. Statement of these ⟨results⟩:

$\frac{5}{2}$	$\frac{5}{2}$	$\frac{8}{2}$	$\frac{11}{2}$	visible $\frac{29}{2}$

The sum of the ⟨first four⟩ terms is $\frac{29}{2}$. The visible, $\frac{29}{2}$, is divided ⟨by ths⟩:

$\frac{2}{29}$	$\frac{29}{2}$

The result is 1. ⟨Each term⟩, multiplied by this, remains the same.

Thus are ⟨series involving⟩ negative quantities.

⟨A section on⟩ the three kinds ⟨of problems⟩ ends.

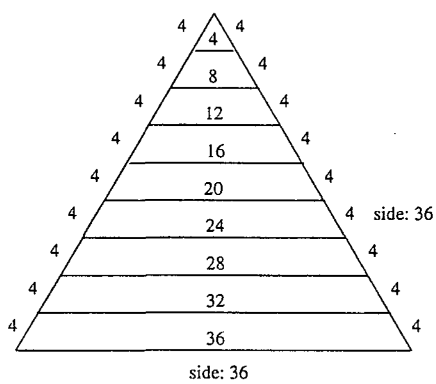
⟨To cite Sūtra N12 again⟩:

> 'Having put down unity in the place of zero, ⟨one should⟩ then make additions or subtractions, and multiplications. ... '

IV 12 (26^v)

⟨*Example 1 for Sūtra C5.*⟩

... The result is 7 ... Now, pairs: 4, 36; half of this ... Now, eight: 8, 32; half, 20. The result ... 16, 28; half. The result ... 24, 16; half. The result ... Now, triplets: three ... 36, 20, 4; of this triplet ... 32, 20, 8; hence the divisor(?) ... 28, 20, 12; again ... 24, 20, 16; ...



V 1 (38#3^v)

(a) . . . made: 1 . . .

(b) . . . Having made . . . : 3. . . . multiplied . . . Three hundred *rūpas* were obtained by five men. What is the very first property?

(c)

120	visible 225

. . .

(d) . . . is subtracted . . . One should . . . the share to the remainder: $\frac{16}{1}$. Here, division by this: $\frac{32}{16}$. The quotient is 2. . . .

(e) . . . 20, 40. 1 . . .

(f) . . .

(g)[29]

$\frac{1}{1}$	$\frac{10}{1}$	$\frac{10}{1}$	result: 100
$\frac{1}{1}$	$\frac{10}{1}$	$\frac{12}{1}$	result: 120

(h) Division of the result: $\frac{28}{2}$; the result is $\frac{14}{1}$. 'One should point out the quotient as the share.'

(i) ⟨*Example 9 for Sūtra N1.*⟩

. . .

$\frac{7}{1}$	$\frac{9}{1}$	$\frac{14}{1}$	visible $\frac{60}{1}$

The sum of the shares is 30; divided: $\frac{1}{30}$. The ⟨visible⟩ quantity is this: 60. The result is 2. By this are severally multiplied ⟨the shares⟩; the result is: 14, 18, 28. The sum is 60.

(j) Statement.

V 2 (38#3^r)

⟨*Example 1 for Sūtra N13.*⟩

. . . one pot ⟨each⟩ of honey, water, and milk, mixed up into one, . . .

Computation. 'Having put down as many ⟨numerals representing each⟩ share as substances' ⟨Sūtra N13⟩:

4	5	6
4	5	6
4	5	6

'And placed the sum of the shares ⟨under each term⟩' ⟨Sūtra N13⟩:

$\frac{4}{15}$ honey	$\frac{5}{15}$ water	$\frac{6}{15}$ milk
$\frac{4}{15}$	$\frac{5}{15}$	$\frac{6}{15}$
$\frac{4}{15}$	$\frac{5}{15}$	$\frac{6}{15}$

29 This portion belongs to V 4 (38#2^v).

'Multiply separately ⟨the terms in each row⟩ by ⟨each of⟩ the shares' ⟨Sūtra N13⟩. ... of ... is made. ⟨The terms in the three rows are⟩ multiplied, ⟨in order⟩, by four, five, and six.

⟨honey⟩	⟨water⟩	⟨milk⟩	
$\frac{16}{15}$	$\frac{20}{15}$	$\frac{24}{15}$	⟨1st pot originally filled with honey⟩
$\frac{20}{15}$	$\frac{25}{15}$	$\frac{30}{15}$	⟨2nd pot originally filled with water⟩
$\frac{24}{15}$	$\frac{30}{15}$	$\frac{36}{15}$	⟨3rd pot originally filled with milk⟩

⟨Verification.⟩ The sum of the numbers in the first ⟨column⟩ is $\frac{60}{15}$, to be reduced to 4. ⟨This is the capacity of⟩ the pot ⟨originally filled⟩ with honey. The sum of ⟨the numbers in⟩ the second column is $\frac{75}{15}$, to be reduced to $\frac{5}{1}$. ⟨This is the capacity of the pot originally filled with⟩ water. The sum of ⟨the numbers in⟩ the third column is taken: $\frac{90}{15}$; reduced, it becomes $\frac{6}{1}$. ⟨This is the capacity of the pot originally filled with⟩ milk. | 1 honey(?) ...

V 3 (38#2^r)

⟨*Example 1 for Sūtra C6.*⟩

> ... Having observed ... The parts of the first are ten; ⟨those⟩ of the second twelve; ⟨those⟩ of the third fourteen; ⟨those⟩ of the fourth sixteen; and the parts of the fifth are known to be eighteen. The share of the sixth, whose parts are unknown, is three hundred. It is observed that all ⟨the shares⟩, added up, are twelve hundred only. ...

V 4 (38#2^v)

... property (or amount) ...... is this: 10. This is multiplied by the parts of each; the results are: 100, 120, 140, 160, 180, 200, and 300. Thus, the ⟨total⟩ amount is $\frac{1200}{1}$.

Verification by means of the *trairāśika*:

$\frac{1}{1}$	$\frac{10}{1}$	$\frac{10}{1}$	result: 100
$\frac{1}{1}$	$\frac{10}{1}$	$\frac{12}{1}$	result: 120
$\frac{1}{1}$	$\frac{10}{1}$	$\frac{14}{1}$	result: 140
$\frac{1}{1}$	$\frac{10}{1}$	$\frac{16}{1}$	result: 160
$\frac{1}{1}$	$\frac{10}{1}$	$\frac{18}{1}$	result: 180
$\frac{1}{1}$	$\frac{10}{1}$	$\frac{20}{1}$	result: 200
$\frac{1}{1}$	$\frac{10}{1}$	$\frac{30}{1}$	result: 300

Thus, the ⟨total⟩ amount is 1200.

V 5 (38#1^r)

Sūtra ⟨*N14*⟩.

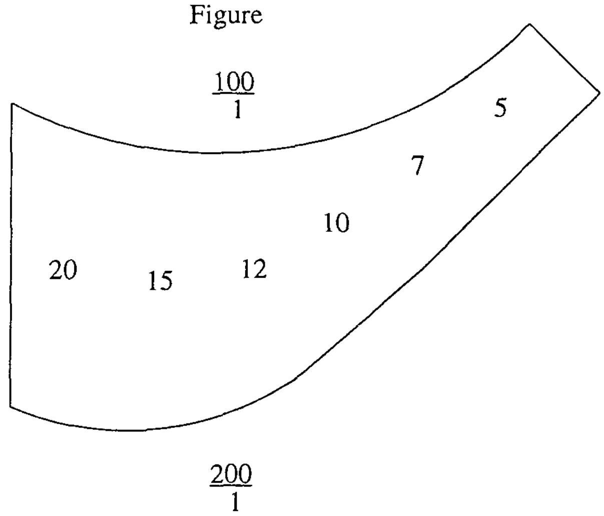
... with certainty. ... division ⟨of⟩ the sum by that ⟨number of the places⟩ where ⟨the length is measured⟩. One should also make division by that ... The breadth of the geometrical figure ...

Example ⟨*1 for Sūtra N14*⟩.

⟨The length of⟩ the back is two hundred, and ⟨that⟩ at the belly, ⟨measured⟩ in the same direction, is one hundred. As for the breadth, the measurements at different places[30] would be twenty, fifteen, twelve, ten, seven, and five. The size ⟨in another direction⟩ is supposed at five places to be seven, five, three, two, and one. What is the working ⟨volume⟩ of that draught-animal, and ⟨what is its⟩ price? Let it be told to me.

Statement of the geometrical figure is made.

Figure



Computation. ... the geometrical figure ... : 300. Having divided into two: 150. The sum regarding the breadth ... This is ... at six places ...

V 6 (38#1^v)

... Their sum(?) should be divided ... multiplied. The result is 6210. This is the measure of the trunk (or torso?) of the draught-animal.

The price should be computed by means of the *trairāśika*. The lower factor: by sixty-four ⟨*maṇḍalakas*⟩ would be a *ṭalla*; otherwise by thirty-two *maṇḍalakas* a *ṭallikā*. This is the factor, which should be chosen according to wish. Now, an illustration of the computation by means of the *ṭalla*: if the price of one *ṭalla* is one ⟨monetary unit⟩, then what is the price of sixty-two hundred and ten ⟨*maṇḍalakas*⟩?

Of one *ṭalla*, ⟨i.e.,⟩

30 *tatthisthāne*. Alternative readings: *bhaḍḍisthāne* = Skt. *bhaṇḍi-* (at wavy places), or *bhattisthāne* = Skt. *bhakti-* (at sections).

by $\frac{64}{1}$ *maṇaleās*	result: $\frac{1}{1}$ for price	by $\frac{6210}{1}$ *maṇaleās*

The result is . . . What is bought at the price? . . .

VI 1 (29^r)

Sūtra ⟨N15⟩.

Having put down any optional number for the first ⟨unknown⟩, one should subtract successively that ⟨number⟩ and the rest ⟨from the given numbers⟩. One should point out half the sum of the optional number and the ⟨final⟩ remainder as the value of the first ⟨unknown⟩.

Example ⟨1 for Sūtra N15⟩.

Quantities ... There, the mixed quantity of the first and the second is thirteen; the mixed quantity of the second and the third is fourteen; and the mixed quantity of the first and the third is said to be fifteen. What shall be the value of each? Let it be told to me, if you know it.

$\frac{13}{1}$	$\frac{14}{1}$	$\frac{15}{1}$

Computation. 'Having put down any optional number for the first' ⟨Sūtra N15⟩. In the present case, the optional is ⟨taken to be⟩ five: 5. This is ⟨supposed to be⟩ the value of the first. Statement:

$\frac{5}{1}$	$\frac{13}{1}$	$\frac{14}{1}$	$\frac{15}{1}$

'One should subtract successively that ⟨number⟩ and the rest ⟨from the given numbers⟩' ⟨Sūtra N15⟩. Five should be subtracted from the first ⟨given⟩ number; the remainder is 8. This is to be subtracted from fourteen; the remainder is 6. This is to be subtracted from fifteen; the remainder is ⟨9⟩. ...

VI 2 (29^v)

Example ⟨2 for Sūtra N15⟩.

The mixed quantity of the first and the second is said to be sixteen; that of the second and the third seventeen; that of the third and fourth eighteen; that of the fourth and the fifth nineteen; and that of the first and the fifth twenty. What shall be the value of each? O best of calculators! ⟨Tell me⟩, if you know it.

$\frac{16}{1}$	$\frac{17}{1}$	$\frac{18}{1}$	$\frac{19}{1}$	$\frac{20}{1}$

Computation. 'Having put down any optional number for the first' ⟨Sūtra N15⟩. In the present case, the optional ⟨is taken to be⟩ 10. 'One should subtract successively that ⟨number⟩ and the rest ⟨from the given numbers⟩' ⟨Sūtra N15⟩. There, ⟨the 10 is⟩ subtracted from the first; the remainder is 6. This should be subtracted from the second: 11. This should be subtracted from the third: 7. This should be subtracted from the fourth: 12. This should be subtracted from the fourth: 8. ...

VI 3 (27#^{v})

... the value of the first. Thus, the statement of the ⟨results⟩ mentioned above in order is made.

first	9	second	7	third	10	fourth	8	fifth	11
second	7	third	10	fourth	8	fifth	11	first	9

⟨The numbers in each cell are⟩ added up; the result for each is: 16, 17, 18, 19, and 20. One should calculate in this way everywhere.

VI 4 (27#^{r})

⟨*Example 1 for Sūtra N16.*⟩

... therefore ...

multiplier 4	multiplier 3

Computation. 'Having added unity to each ⟨of the two multipliers⟩' ⟨Sūtra N16⟩. Unity being added to each, the result is: 5 and 4. 'The product of the multipliers' ⟨Sūtra N16⟩. In the present case, the multipliers are 3 and 4. The product, 12, 'is decreased by unity' ⟨Sūtra N16⟩: 11. ⟨This is⟩ the product less one. Four and five are ⟨separately⟩ added to this; the result⟨s⟩: 15 and 16. These are ⟨solutions when⟩ the multipliers are three and four. The original quantities, four and five, ⟨corresponding respectively to 16 and 15⟩, have already been produced: 5 and 4. These are ...

⟨The end of the *N16*-th *sūtra.*⟩[31]

Sūtra ⟨*N17*⟩.

> The two multipliers ... the value. The product of the multipliers, decreased by unity, ... the result ... the ⟨number of⟩ coins(?).

31 There exists an ending mark.

VII 1 (65^v)

⟨*Example 1 for Sūtra N18.*⟩

... In that case, what is the period? Let it be told.

first term $\frac{1}{1}$	common difference $\frac{1}{1}$	period $\frac{0}{1}$	sum $\frac{60}{1}$

Computation. 'While the sum is multiplied by eight and the common difference *(uttara)*' ⟨Sūtra N18⟩. ⟨The sum, 60, is⟩ multiplied by eight: 480. Multiplied ⟨also⟩ by the common difference, it remains the same. 'Twice the first term' ⟨Sūtra N18⟩. The first term is doubled: 2. 'Decreased by the common difference *(caya)*' ⟨Sūtra N18⟩. ⟨The word⟩ *caya* is ⟨a synonym of⟩ *uttara*. When one has subtracted the common difference from this, ⟨2⟩, there remains one: 1. 'And squared. When one has added ⟨the square⟩ to it' ⟨Sūtra N18⟩, the square root of the ⟨resulting⟩ value 481 ⟨is to be extracted, but the number does not have the exact root⟩. The approximate root ⟨obtained by means of Sūtra Q2⟩ is $21\frac{40}{42}$. 'A factor into a factor' ⟨Sūtra Q1⟩: $882\frac{40}{42}$. The remainder,[32] forty, should be placed separately ⟨and preserved for verification⟩: 40; and ⟨then it⟩ 'should be added to the top' ⟨Sūtra Q1⟩: $\frac{922}{42}$. 'Decreased by the square root of that (i.e., the square obtained above)' ⟨Sūtra N18⟩. 'The square root of that' is 1. Decreased ⟨by this, the $\frac{922}{42}$ becomes⟩ $\frac{880}{42}$. 'Divided by twice the common difference' ⟨Sūtra N18⟩: $\frac{880}{84}$. This is the period. ...

VII 2 (56^v)

⟨Verification.⟩ ...

$\frac{880}{84}$	$\frac{964}{168}$

Multiplied; the result is $\frac{848320}{14112}$. The square of the forty, which has been placed separately, is 1600. This should be subtracted from the upper ⟨factor (or the numerator) of the fraction just obtained⟩; the remainder is $\frac{846720}{14112}$. Reduced, it becomes 60.

56^{v}F^1: ...... is made.
56^{v}F^2: ... multiplied ...
56^{v}F^3: $\frac{\square}{84}$

VII 3 (56^r)

⟨2nd solution of Example 1 for Sūtra N18.⟩

... 'And squared. When one has added ⟨the square⟩ to it' ⟨Sūtra N18⟩: 481. The square root ⟨obtained before⟩ is $21\frac{20}{21}$. This is inaccurate. Therefore, ⟨we recall Sūtra Q2 again⟩.

⟨*Sūtra Q2.*⟩

> The divisor for the remainder from the diminution of the non-square number by the square of the first approximation, is twice ⟨the first approximation⟩. Division of half the square of that (i.e., the quotient just obtained) by the second approximation ⟨is made⟩. Subtraction ⟨of the result from the second approximation gives the third approximation⟩. Less the square.

32 This nomenclature follows that of Sūtra Q2: $481 - 21^2 = 40$.

⟨The first half of this rule⟩, 'The divisor for the remainder ... is twice,' has been already applied, ⟨the result being $21\frac{20}{21}$⟩. 'The square of that,'

21	− {			'the 2nd approx.'	21	: divisor }
$\frac{20}{21}$		$\frac{400}{441}$	'half' $\frac{1}{2}$		$\frac{20}{21}$	

The remainder, ⟨400⟩, should be removed ⟨and preserved separately for verification⟩. When one has applied ⟨the rule⟩, 'a factor into a factor' ⟨Sūtra Q1⟩, ⟨the result is⟩ divided: $\frac{21}{461}$. 'The lower should be multiplied by the lower, and the upper by the upper' ⟨Sūtra Q3⟩. ⟨The result is $\frac{400}{19362}$.⟩ One should ⟨then⟩ subtract the square (*varga*), ⟨which is also called⟩ *yāva*. There, reduction to the same ⟨denominator⟩ is made:

$\frac{425042}{19362}$	$-\frac{400}{19362}$

Remainder: $\frac{424642}{19362}$.

...

56ʳF²: How many days ...

VII 4 (64ʳ)

⟨Verification.⟩ ...

$\frac{405280}{38724}$	$\frac{444004}{38724}$

... Half ⟨of the latter⟩ should be made. Statement of it:

$\frac{405280}{38724}$	$\frac{444004}{77448}$

When one has multiplied, ⟨the following⟩ is produced. ⟨In multiplication of fractions⟩, one should multiply the numerators by the numerators, and the denominators by the denominators. ...

$\frac{179945941120}{2999096352}$

From the upper number of this ⟨fraction⟩, the remainder is produced. ...

−160000

...

VII 5 (64ᵛ)

⟨*Example 2 for Sūtra N18.*⟩

... 'And squared' ⟨Sūtra N18⟩: 1. 'When one has added ⟨the square⟩ to it' ⟨Sūtra N18⟩: 41. 'The square root' ⟨Sūtra N18⟩. 'The divisor for the remainder ... is twice' ⟨Sūtra Q2⟩: $6\frac{5}{12}$. The remainder, five, should be placed separately ⟨and preserved for verification⟩. 'A factor into a factor' ⟨Sūtra Q1⟩: $\frac{77}{12}$. 'Decreased by the square root of that (i.e., the square obtained above)' ⟨Sūtra N18⟩. 'The square root of that', 1, should be subtracted: $\frac{65}{24}$. This is the period ⟨of the arithmetical progression⟩.

Verification:

first term $\frac{1}{1}$	common difference $\frac{1}{1}$	period $\frac{65}{24}$

⟨The period is⟩ 'decreased by unity': $\frac{41}{24}$; 'multiplied by the common difference': ⟨$\frac{41}{24}$⟩; 'halved': $\frac{41}{48}$; 'increased by the first term': $\frac{89}{48}$; 'and multiplied by the period' ⟨Sūtra Q12⟩: $\frac{5785}{1152}$. ...

VII 6 (57^v)

⟨2nd solution of Example 2 for Sūtra N18.⟩

... 'While the sum is multiplied by eight and the common difference': 40; 'twice the first term is decreased by the common difference and squared.' 'When one has added ⟨the square⟩ to it': 41; 'the square root' ⟨Sūtra N18⟩: $6\frac{5}{12}$. ⟨In order to obtain this value, the first half of Sūtra Q2⟩, 'The divisor for the remainder ... is twice,' has ben applied, ⟨but⟩ it is inaccurate. Therefore, ⟨we recall Sūtra Q2 again⟩:

⟨Sūtra Q2.⟩

> The divisor for the remainder from the diminution of the non-square number by the square of the first approximation, is twice ⟨the first approximation⟩. Division of half the square of that (i.e., the quotient just obtained) by the second approximation ⟨is made⟩. Subtraction ⟨of the result from the second approximation gives the third approximation⟩. Less the square.

⟨The first half of this rule⟩, 'The divisor for the remainder ... is twice,' has already been applied: $6\frac{5}{12}$. 'The square of that,'

6	−				'the 2nd approx.'	6	: divisor
$\frac{5}{12}$		$\frac{25}{144}$	'half'	$\frac{1}{2}$		$\frac{5}{12}$	

The division is made; the result is $\frac{12}{77}$.

VII 7 (57^r)

...

6			Remainder:	6
$\frac{770}{1848}$	−	$\frac{25}{1848}$		$\frac{745}{1848}$

'A factor into a factor' ⟨Sūtra Q1⟩: $\frac{11833}{1848}$. ⟨Since the latter half of Sūtra Q2⟩, 'Division of half the square of that by the second approximation. Subtraction. Less the square,' has been applied, this is an ⟨accurate⟩ square root ⟨of 41⟩. 'Decreased by the square root of that' ⟨Sūtra N18⟩. 'The square root of that' is one: 1. This, after the reduction to the same ⟨denominator⟩, is subtracted; the result is $\frac{9985}{1848}$. 'Divided by twice the common difference' ⟨Sūtra N18⟩. The common difference,

⟨1⟩, is doubled: 2. By this is divided ⟨the last fraction⟩; the result is $\frac{9985}{3696}$. This is the period of ⟨the arithmetical progression whose sum is⟩ five.

Verification of this ⟨answer⟩.

Sūtra ⟨Q9⟩.

One quantity should be placed in two places. Unity ...

VII 8 (45^r)

⟨*Example 3 for Sūtra N18.*⟩

...

⟨Verification.⟩ ⟨The period, $\frac{59425}{49200}$, is⟩ 'decreased by unity': $\frac{10225}{49200}$; 'multiplied by the common difference': $\frac{10225}{32800}$; 'halved': $\frac{10225}{65600}$; 'increased by the first term': $\frac{108625}{65600}$; 'and multiplied by the period' ⟨Sūtra Q12⟩. Multiplied by the period:

$$\frac{6455040625}{3227520000}.$$

From this, the square of the twenty-five ⟨that has been preserved separately⟩ is subtracted, and the upper ⟨term of the fraction is rewritten⟩:

$$\frac{6455040000}{3227520000}.$$

The division is made; the quotient is 2. This is the sum ⟨of the arithmetical progression⟩.

Another ⟨example. *Example 4 for Sūtra N18.*⟩

first term 1	common difference 1	period $\frac{0}{1}$	sum $\frac{7000}{1}$
$\frac{1}{2}$	$\frac{1}{2}$		

'While the sum is multiplied by eight and the common difference, twice the first term is decreased by the common difference, and squared. When one has added ⟨the square⟩ to it' ⟨Sūtra N18⟩: $\frac{336009}{4}$. The square root of four is 2. ...

VII 9 (45^v)

... 768. half of this is 384. The square of this is 147456. The square of this is 21743271936. All these ⟨fractions are to be mutually⟩ multiplied. The square ⟨for verification⟩ has been removed ⟨to be separately preserved⟩. When one has applied ⟨Sūtra Q1⟩: 'a factor into a factor', ⟨the result⟩, when divided, becomes $-\frac{1158}{671250}$. One should multiply the numerators by the numerators, ⟨and the denominators by the denominators⟩. In the present case, the ⟨resulting⟩ denominator and numerator should be reduced; the result is:

$$\begin{array}{|ccc|}579 & & \\ \frac{768}{1158} & - & \frac{294912}{777307500} \\ \hline\end{array}$$

Reduced to the same color:

$$\begin{array}{|ccc|}579 & & \\ \frac{515520000}{777307500} & - & \frac{294912}{777307500} \\ \hline\end{array}$$

When one has subtracted, the remainder is:

$$\begin{array}{|c|}579 \\ \frac{515225088}{777307500} \\ \hline\end{array}$$

⟨Sūtra Q1:⟩ 'a factor into a factor,' is applied; the result is:

$$\frac{450576267588}{777307500}.$$

Divided by two or the square root ⟨of four obtained above⟩:

$$\frac{450576267588}{1554615000}.$$

This is the square root ⟨of $\frac{336009}{4}$⟩. . . .

VII 10 (46^r)

⟨Verification.⟩ The period,

$$\frac{448244345088}{4663845000},$$

is 'decreased by unity':

$$\frac{443580500088}{4663845000};$$

'multiplied by the common difference':

$$\frac{221790250044}{1554615000};$$

'halved':

$$\frac{110895125022}{1554615000};$$

'increased by the first term':

$$\frac{113227047522}{1554615000};$$

'and should be multiplied by the period' ⟨Sūtra Q2⟩:

$$\frac{5075338376274674327l936}{7250483394675000000}.$$

From the upper ⟨term⟩ of this ⟨fraction⟩, subtraction of the square, 21743271936, ⟨is made. When it has been⟩ subtracted, the upper ⟨term⟩ is produced ⟨anew⟩. Statement:

$$\frac{50753383762725000000000}{7250483394675000000}.$$

The division being made, the quotient is 7000. This is the sum ⟨of the arithmetical progression⟩.

VII 11 (46^v)

⟨*Example 1 for Sūtra C7.*⟩

... men ...	...	...	...
20 *maṇḍakās*	8 *maṇḍas*	6 *maṇḍas*	8(?) *maṇḍas*

Another problem. ⟨*Example 2 for Sūtra C7.*⟩

> Twenty living creatures, monkeys etc., cost twenty ⟨*paṇas* in total⟩. ... *paṇas*. ⟨Each of⟩ the horses costs as much as four *paṇas*, and one deer a half *paṇa*. ...[33] Twenty of these living creatures ⟨cost⟩ twenty ⟨*paṇas* in total⟩.

Computation. Three horses can be obtained for twelve *paṇas*. ... for ... *paṇas*. Three *śūdras*(?) ...

VII 12 (58^v)

⟨*Example 3 for Sūtra C7.*⟩

...

Statement is made.

$\frac{1}{1}$ man	$\frac{1}{1}$ girl	$\frac{1}{1}$ *śūdra*	Visible:	20 persons.
$\frac{3}{1}$ *maṇḍas*	1 *maṇḍas* $\frac{1}{2}$	$\frac{1}{2}$ *maṇḍa*		20 *maṇḍas*.

... is given(?); the result is: 2 men, 5 girls, and 13 *śūdras*. ... *maṇḍas* ...

33 The passage, '⟨□□⟩□ḍhaleāpottīleāgaṇe,' has not been understood.

VII 13 (58^r)

Example ⟨1 for Sūtra C8⟩.

Twenty-six, fifty-three, twenty-nine, sixty-two, twenty-six, forty-four, seventy, sixty-four, ninety-nine, forty-two,[34] and then eighty-three, twenty-one, eighteen,[35] and seven.

2653296226447064994⟨2⟩8321⟨1⟩87.

. . . This . . .

34 Or, 'forty-three,' or 'forty-six.'
35 Or, 'twenty-eight,' or 'thirty-,' or 'sixty-,' or 'eighty-.'

VIII 1 (59^v)

Blank

VIII 2 (59^r)

...

Example ⟨1 for Sūtra 50⟩.

'What number, when increased by five, has[36] a square rot? The same number, when decreased by seven, ⟨also⟩ has a square root. What is that number?' This has been questioned.

$\frac{0}{1}$ $\frac{5}{1}$ added, root $\frac{0}{1}$	that $\frac{0}{1}$ − $\frac{7}{1}$, root $\frac{0}{1}$ [37]

Computation. 'The sum of the addendum and the subtrahend' ⟨Sūtra 50⟩: 12. Its half is 6. Decreased by two: 4. Halved: 2. ⟨Its⟩ square, 4, 'should be added to the subtrahend' ⟨Sūtra 50⟩. 'To the subtrahend': −7. Increased by this: 11. This is that number ⟨which satisfies the conditions⟩.

Statement for a verification of this ⟨answer⟩:

$\frac{11}{1}$ added $\frac{5}{1}$, root $\frac{4}{1}$	$\frac{11}{1}$ − $\frac{7}{1}$, root $\frac{2}{1}$

⟨The end of⟩ the fiftieth *sūtra*: 50.

Sūtra ⟨51⟩.

The difference of ⟨the numbers of⟩ the cows ⟨possessed by the two persons⟩ should be made. Make also ⟨the difference of their⟩ properties ⟨in cash⟩. ...

VIII 3 (60^r)

⟨Example 1 for Sūtra 51.⟩

...

□□ cows	□□ *rūpas*	□□
$\frac{10}{1}$ cows	$\frac{8}{1}$ *rūpas*	

This ⟨problem⟩ has been expounded on the nineteenth leaf.[38]

⟨The end of⟩ the fifty-first *sūtra*: 51.

36 *mūlada*, lit. means 'gives a square root.'
37 The manuscript reads '0' for the last '$\frac{0}{1}$.'
38 The leaf is missing.

Sūtra ⟨52⟩.

The difference of the income and the expense is divided (i.e., made into its reciprocal), and multiplied by the visible. What is obtained shall be the time ⟨for consumption⟩. This is a rule for a problem of expense.

Example ⟨1 for Sūtra 52⟩.

A certain man would earn five ⟨*dīnāras*⟩ every other day, and spend nine ⟨*dīnāras*⟩ every three days. His stock is thirty ⟨*dīnāras*⟩. In what time does the consumption of his earnings ⟨and stock take place⟩?

5 *dīnāras*	9 *dīnāras*	visible
2 days	3 days	30

Computation. 'The difference of the income and the expense' ⟨Sūtra 52⟩. In the present case, the ⟨daily⟩ income is $\frac{5}{2}$ ⟨*dīnāras*⟩, and the ⟨daily⟩ expense $\frac{9}{3}$ ⟨*dīnāras*, which is⟩ to be reduced to $\frac{3}{1}$ ⟨*dīnāras*⟩. When one has made the difference of the two ⟨numbers⟩, $\frac{1}{2}$, it is divided: $\frac{2}{1}$. 'Multiplied by the visible' ⟨Sūtra 52⟩. The visible is 30. Multiplied by this, it becomes 60. In this time (60 days) the consumption of his earnings ⟨and stock takes place⟩.

VIII 4 (60^v)

...

Verification by means of the *trairāśika*:

2 ⟨days⟩	5 ⟨*dīnāras*⟩	60 days	result: $\frac{150}{1}$ *dīnāras*
3 ⟨days⟩	9 ⟨*dīnāras*⟩	60 days	result: $\frac{180}{1}$ *dīnāras*

...

⟨The end of⟩ the fifty-second *sūtra*: 52.

Sūtra ⟨53⟩.

The days and the money are ⟨taken respectively to be⟩ a denominator and ⟨its⟩ numerator. Their difference is divided (i.e., made into its reciprocal). What is obtained, when multiplied by two and the ⟨money⟩ given ⟨by one person to the other⟩, is the time for arriving at equal amounts of properties.

Example ⟨1 for Sūtra 53⟩.

O learned one! One hired servant would earn five ⟨*rūpakas*⟩ every three days. O wise man! Another earns six ⟨*rūpakas*⟩ evey five days. Seven *rūpakas* are given by the first to the second. In what time, after the giving, do their properties become equal to each other? Let it be told.

5 *rūpakas*	6 *rūpakas*	given
3 days	5 days	7

Computation. 'The days and the money are ⟨taken respectively to be⟩ a denominator and ⟨its⟩ numerator. Their difference is divided' ⟨Sūtra 53⟩. ...

VIII 5 (61^r)

Divided: $\frac{15}{7}$. The ⟨amount⟩ given, 7, is doubled: 14. Multiplied:

$\frac{15}{7}$	$\frac{14}{1}$

The result is $\frac{30}{1}$. In this time (30 days) their properties become equal to each other.

For a verification, the *trairāśika* is applied.

$\frac{3}{1}$	$\frac{5}{1}$	$\frac{30}{1}$	result: 50 [39]
$\frac{5}{1}$	$\frac{6}{1}$	$\frac{30}{1}$	⟨result:⟩ 36

'Seven ⟨*rūpakas*⟩ are given by the first to the second' ⟨Example 1⟩: 7. The remainder ⟨of 50 − 7⟩ is 43, ⟨and the sum of 36 + 7 is also⟩ 43. These have been produced as the properties equal to each other.

Example ⟨2 for Sūtra 53⟩.

> A certain pair of princes are taken care of by the king, ⟨who⟩, daily ⟨gives⟩ two ⟨and⟩[40] one sixth ⟨*dīnāras*⟩ to one ⟨of them⟩, and one and a half ⟨*dīnāras*⟩ to the second. Ten *dīnāras* are given by the first to the second. In what time ⟨will there be⟩ equality ⟨of their properties⟩? Having calculated, you tell me quickly.

$\frac{13}{6}$	$\frac{3}{2}$	given $\frac{10}{1}$

Computation. 'The difference of the daily moneys' ⟨Sūtra 53⟩.[41] In the present case, the daily money for the first ⟨prince⟩ is $\frac{13}{6}$ ⟨*dīnāras*⟩, and ⟨that⟩ for the second $\frac{3}{2}$ ⟨*dīnāras*⟩. ...

VIII 6 (61^v)

...

Verification by means of the *trairāśika*:

$\frac{1}{1}$	$\frac{13}{6}$	$\frac{30}{1}$	result: 65
$\frac{1}{1}$	$\frac{3}{2}$	$\frac{30}{1}$	result: 45

Ten ⟨*dīnāras*⟩ are given by the first to the second. The result is: 55 and 55. The equal properties are produced.

---

39 The manuscript reads '30' for '$\frac{30}{1}$' in the second row.

40 The prefix, *sa*, is written in between the lines of writing, but it would break the meter.

41 The *sūtra* is slightly modified here.

⟨The end of⟩ the fifty-third *sūtra*: 53.

Sūtra ⟨54⟩.

The buying rate is divided by the selling rate, and decreased by unity. One should again divide (i.e., make the reciprocal of) ⟨the result⟩, and multiply by the net profit. There will be the capital.

Example ⟨1 for Sūtra 54⟩.

One, who buys ⟨a certain thing at the rate of⟩ seven articles for two ⟨*paṇas*⟩, sells ⟨the same thing at the rate of⟩ six for three. The net profit would be eighteen ⟨*paṇas*⟩. What is the capital in that case? Let it be told.

$\frac{7}{2}$	$\frac{6}{3}$	net profit $\frac{18}{1}$

Computation. 'The buying rate is divided by the selling rate' ⟨Sūtra 54⟩. In the present case, the buying rate is $\frac{7}{2}$, and the selling rate $\frac{6}{3}$, to be reduced to $\frac{2}{1}$. By this,

VIII 7 (62^r)

⟨the $\frac{7}{2}$ is⟩ divided: $\frac{7}{4}$. 'Decreased by unity' ⟨Sūtra 54⟩: $\frac{3}{4}$. Again divided: $\frac{4}{3}$. The net profit is $\frac{18}{1}$. By this is multiplied ⟨the $\frac{4}{3}$⟩; the result is 24 ⟨*paṇas*⟩. This has been produced as the capital.

A verification of this ⟨answer is made⟩ by means of the *trairāśika*: if seven articles are obtained for two ⟨*paṇas*⟩, then what is for twenty-four ⟨*paṇas*⟩?

$\frac{2}{1}$	$\frac{7}{1}$	$\frac{24}{1}$

Result: 84 articles.

The ⟨*trairāśika* for the⟩ selling of this ⟨commodity⟩ is made: if three *paṇas* are obtained for six ⟨articles⟩, then what is for eighty-four ⟨articles⟩?

$\frac{6}{1}$	$\frac{3}{1}$	$\frac{84}{1}$

Result: 42 ⟨*paṇas*⟩.

The capital, 24 ⟨*paṇas*⟩, is to be subtracted ⟨from the result⟩; the remainder is 18 ⟨*paṇas*⟩. This is the net profit ⟨given in the problem⟩.

⟨The end of⟩ the fifty-fourth *sūtra*: 54.

⟨Sūtra 55.⟩

One should divide (i.e., make the reciprocal of) the selling rate, multiply the buying rate ⟨by the result⟩, and multiply the capital by the ⟨last result⟩ decreased by unity. What is obtained is the net profit.

Example ⟨1 for Sūtra 55⟩.

One, who buys ⟨a certain thing at the rate of⟩ seven for two ⟨monetary units⟩, sells ⟨the same thing at the rate of⟩ six for three. The capital would be twenty-four. What is the net profit in that case? Let it be told.

$\frac{7}{2}$	$\frac{6}{3}$	capital $\frac{24}{1}$

Computation. The sellng rate is $\frac{6}{3}$. Divided: $\frac{3}{6}$. The buying rate is $\frac{7}{2}$. By this,

VIII 8 (62^v)

⟨the $\frac{3}{6}$ is⟩ multiplied: $\frac{21}{12}$. Decreased by unity: $\frac{9}{12}$. The capital is $\frac{24}{1}$. By this is multiplied ⟨the $\frac{9}{12}$⟩; the result is $\frac{18}{1}$. This is the net profit.

Verification by means of the *trairāśika*:

$\frac{2}{1}$	$\frac{7}{1}$	$\frac{24}{1}$	result: $\frac{84}{1}$

Now, ⟨for⟩ the selling:

$\frac{6}{1}$	$\frac{3}{1}$	$\frac{84}{1}$	result: $\frac{42}{1}$

The capital, 24, is to be subtracted ⟨from the result⟩; the remainder is 18. This is the net profit ⟨obtained above⟩.

⟨The end of⟩ the fifty-fifth *sūtra*: 55.

⟨Sūtra 56.⟩

One should divide (i.e., make the reciprocal of) the selling rate, and multiply the buying rate ⟨by the result⟩. It is again divided (i.e., made into its reciprocal). A wise man should ⟨then⟩ multiply the total proceeds ⟨by the last result⟩. What is obtained shall be the capital, and what remains ⟨after the subtraction of the capital from the total proceeds⟩ shall be the amount of the net profit.

Example ⟨1 for Sūtra 56⟩.

A person obtains eight ⟨articles of a ceratin thing⟩ for three ⟨monetary units⟩. In selling ⟨the same thing, the rate is⟩ six ⟨articles⟩ for four ⟨monetary units⟩. The capital and the net profit, taken together, become one hundred and sixty. What is the capital, and what is the net profit? The best of calculators shall tell ⟨that⟩.

$\frac{8}{3}$	$\frac{6}{4}$	total $\frac{160}{1}$

Computation. 'One should divide the selling rate, and multiply the buying rate' ⟨Sūtra 56⟩. In the present case, the selling rate is $\frac{6}{4}$. Divided: $\frac{4}{6}$. The buying rate is $\frac{8}{3}$.

VIII 9 (63^r)

By this is multiplied ⟨the $\frac{4}{6}$⟩: $\frac{32}{18}$. Divided: $\frac{18}{32}$. The total proceeds are $\frac{160}{1}$. Multiplied by this: $\frac{90}{1}$. This has been produced as the capital, to be subtracted ⟨from the total proceeds⟩; the remainder is $\frac{70}{1}$. This is the net profit.

Verification:

$\frac{3}{1}$	$\frac{8}{1}$	$\frac{90}{1}$	result: $\frac{240}{1}$

The verification ⟨continues⟩ in selling:

$\frac{6}{1}$	$\frac{4}{1}$	$\frac{240}{1}$	result: $\frac{160}{1}$

The capital, 90, should be subtracted ⟨from the last result⟩; the remainder is 70, ⟨which is the net profit obtained above⟩.

⟨The end of⟩ the fifty-sixth *sūtra*: 56.

⟨*Sūtra 57.*⟩

The selling rate should be divided (i.e., made into its reciprocal); and the buying rate is multiplied ⟨by the result⟩. Having subtracted ⟨the last result⟩ from unity, one should point out its reciprocal ⟨multiplied by the debt⟩ as the capital.

Example ⟨1 for Sūtra 57⟩.

The square of four is obtained for five ⟨*rūpakas*⟩ by a certain man of pride, and six is sold for one *rūpaka*. When he has accomplished his buying and selling, he incurs debts of fifty-six ⟨*rūpakas*⟩. Let his capital be told.

$\frac{16}{5}$	$\frac{6}{1}$	debts $-\frac{56}{1}$

Computation. 'One should divide the selling rate' ⟨Sūtra 56⟩: $\frac{1}{6}$. The buying rate is $\frac{16}{5}$. Multiplied by this: $\frac{16}{30}$. 'Having subtracted ⟨the result⟩ from unity' ⟨Sūtra 57⟩: $\frac{14}{30}$.

VIII 10 (63^v)

Divided: $\frac{30}{14}$. The debt is $\frac{56}{1}$. Multiplied by this: $\frac{120}{1}$. This has been produced as the capital.

Verification by means of the *trairāśika*:

$\frac{5}{1}$	$\frac{16}{1}$	$\frac{120}{1}$

Result: 384.

Now, the selling of this ⟨commodity⟩:

$\frac{6}{1}$	$\frac{1}{1}$	$\frac{384}{1}$

[42] Result: 64.

The capital, 120, should be subtracted from sixty-four; the remainder is 56 ⟨in the negative⟩. This much of debts is made.

⟨The end of⟩ the fifty-seventh *sūtra*: 57.

⟨Sūtra 58.⟩

When a ⟨sales⟩ tax is imposed on garments, calculate correctly the tax ⟨to be paid in cash⟩, by means of the rule of *trairāśika*, from ⟨the fractional portion of⟩ a garment remaining after that ⟨tax in kind⟩ has been taken away.

Example ⟨1 for Sūtra 58⟩.

A ⟨sales⟩ tax on garments is one twentieth ⟨of the value⟩. A certain man buys forty-two garments by *paṇas*. Two garments are taken away as ⟨a part of⟩ the tax. ... Also, ten *paṇas* ⟨are paid as the remaining portion of the tax⟩. What is the price ⟨of a piece of garment⟩? Tell ⟨me⟩, O learned one!

IX 1 (44^v)

⟨*Example 1 for Sūtra C9.*⟩

... ⟨His⟩ stock is seven hundred. When does the consumption of his earnings ⟨and stock take place⟩?

Statement is made:

income 1,	1 days: divisor;	$\frac{8}{1}$ for Bha,	5 days: divisor;	$\frac{1}{1}$ for Pa,
$\frac{1}{2}$	$\frac{1}{3}$		$\frac{1}{3}$	

$\frac{32}{1}$ days: divisor;	2	for Śū, $\frac{36}{1}$ days: divisor	$\frac{1}{1}$ ⟨day⟩ = $\frac{1}{360}$ ⟨year⟩ [43]
	$\frac{1}{4}$ $\frac{1}{4}$		

The amount of ⟨daily⟩ expense is $\frac{223}{144}$, and that of ⟨daily⟩ income ⟨$\frac{9}{8}$. The result obtained by means of Sūtra C9 is⟩ $\frac{280}{61}$ ⟨years⟩. In this time will be the consumption of his earnings ⟨and stock⟩.

⟨Verification:⟩

$\frac{1}{1}$ day	$\frac{223}{144}$	$\frac{280}{61}$ ⟨years⟩	Upper factor: 360.

The result is: 2559 *vajjarakas* and the remainder $\frac{1}{61}$. This is the expense for the period, 4 years, 7 months, 2 days, and the remainder $\frac{28}{61}$. Now, the income ⟨for the same period is calculated⟩.

1 days	1	$\frac{280}{61}$ ⟨years⟩	Upper factor: 360.
$\frac{1}{3}$	$\frac{1}{2}$		

The result is $1859\frac{1}{61}$ ⟨*vajjarakas*⟩. Together with the stock, the total means is $2559\frac{1}{61}$ ⟨*vajjarakas*⟩.

IX 2 (44^r)

⟨Another verification:⟩ ...

$\frac{280}{61}$ ⟨years⟩	2559	$\frac{1}{1}$ day	⟨Lower⟩ factor: 360.
	$\frac{1}{61}$		

⟨The result is⟩ $\frac{223}{144}$. This is the amount of ⟨his daily⟩ expense.

Example ⟨*2 for Sūtra C9*⟩.

The product ⟨of a certain merchant⟩ is ten and a half ⟨*vajjaras*⟩ every two and a third days. In order to worship ⟨Vāsudeva⟩, thirteen and a third ⟨*vajjaras*⟩ are placed ⟨by him⟩ on a mound(?) every three and an eighth days, while ⟨the name of⟩ Vāsudeva is being recited. Every eight and a half days, he would offer thirteen less a quarter ⟨*vajjaras*⟩ for food to Brāhmaṇas seeking the next world and the benefit of others. One and a third *vajjaras* ⟨are spent for⟩ leaves ... and ⟨for⟩ creepers and bamboos of baskets(?) every three and a fifth days. A half ⟨*vajjara*⟩ is ... every one and a half days. ...

43 Bha = Bhavānī (a goddess)? Pa = *paraloka* (the next world)? Śū = Śūlin (a god)?

IX 3 (43^r)

> ... He would maintain ... Twelve and a half ⟨*vajjaras* are spent⟩ for enjoying the best kind of wine every thirty-three and a third days. There are twelve hundred *vajaras* in the store of that merchant. This is the ⟨account of his⟩ expense while ⟨he is⟩ producing (i.e., earning). How long ⟨is he able to live on it⟩? Tell ⟨me⟩, O learned one!

Computation by means of the rule ⟨given in Sūtra C9⟩. There are twelve hundred ⟨*vajjaras*⟩ in his store:

10,	2: divisor;	13,	3: divisor;	13,	8: divisor;	1,	3: divisor;
$\frac{1}{2}$	$\frac{1}{3}$	$\frac{1}{3}$	$\frac{1}{8}$	$-\frac{1}{4}$	$\frac{1}{2}$	$\frac{1}{3}$	$\frac{1}{5}$

$\frac{1}{2}$,	1: divisor;	$\frac{1}{1}$,	5: divisor;	2,	1: divisor;	12,	33: divisor;
		$\frac{1}{2}$	$\frac{1}{3}$	$\frac{1}{4}$ $\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{2}$	$\frac{1}{3}$

$\frac{1}{1}$ ⟨day⟩ = $\frac{1}{360}$ ⟨year⟩	store $\frac{1200}{1}$

Multiplied, ...

IX 4 (43^v)

⟨Verification:⟩

2 ⟨days⟩	10	$\frac{800}{727}$ ⟨years⟩
$\frac{1}{3}$	$\frac{1}{2}$	

Upper factor: 360 days = 1 year.

⟨The result is $1782\frac{486}{727}$ *vajjaras*.⟩ Together with the stock, the total means is $2982\frac{486}{727}$ ⟨*vajjaras*⟩. Now, the total expense ⟨is calculated⟩.

$\frac{1}{1}$ day	$\frac{1807}{240}$	$\frac{800}{727}$ ⟨years⟩

Upper factor: 360 days = 1 year.

⟨The result is⟩ $2982\frac{486}{727}$ ⟨*vajjaras*⟩.

Again, ⟨another verification:⟩

$\frac{800}{727}$ ⟨years⟩	2982	$\frac{1}{1}$ ⟨day⟩
	$\frac{486}{727}$	

Lower factor: 360 days = 1 year.

The result is the amount of the daily ⟨expense⟩: $\frac{1807}{240}$ ⟨*vajjaras*⟩. Thus, everything is ⟨calculated⟩ by means of the *trairāśika*.

Example ⟨3 for Sūtra C9?⟩.

...

X 1 (49^v)

⟨*Example 1 for Sūtra C10.*⟩

. . . ⟨metal⟩ having great lustre . . . ⟨four⟩ *raktis* go in loss, and ⟨also four⟩ *siddhārthas* will vanish ⟨in the course of refinement⟩. In five times five years, five months, and twenty days, what amount of the ⟨metal⟩ having great lustre is refined? Tell ⟨me⟩ exactly.

$\frac{1}{1}$	3 *tolas*	loss:	−4 ⟨*raktis*⟩	25 years	factor: $\frac{360}{1}$
	2 *māṣas*		60	5 months	
	12		4 *siddhārthas*	12	
	3 *aṇḍikās*		8	20 days	
	4			30	
	3 *yavas*				
	4				
	1 *kalā*,	6: divisor			
		$\frac{1}{4}$			
	1 *pāda*				
	4				
	1 *mūdṛkā*				
	4				

The numbers in the middle section ⟨of the enclosure are mutually⟩ multiplied; the result is $\frac{62321}{19200}$ ⟨*tolas*⟩. The loss should be subtracted; the result is $\frac{60881}{19200}$ ⟨*tolas*⟩. Lower factors: 7 *tolas* = 1 *pala*, and 2000 *palas* = 1 *bhāra*. All ⟨terms are mutually⟩ multiplied: $\frac{558278770}{268800000}$ ⟨*bhāras*⟩. Divided: 2 *bhāras* ⟨and the remainder, which is⟩, since 2000 *palas* = 1 *bhāra*, 153 *palas* ⟨and the remainder, which is⟩, since 7 *tolas* = 1 *pala*, 6 *tolas* ⟨and the remainder, which is⟩, since 192 *yavas* = 1 *tola*,

X 2 (49^r)

3 *yavas* ⟨and the remainder, which is⟩, since $6\frac{1}{4}$ *kalās* = 1 *yava*, 4 *kalās* ⟨and the remainder, which is⟩, since 4 *pādas* = 1 *kalā*, 1 *pāda* ⟨and the remainder, which is⟩, since 4 *mūdṛkās* = 1 *pāda*, 2 *mūdṛkās*.

Example ⟨2 for Sūtra C10⟩.

... They worship a goddess every day with principal rites, while I, having purchased a certain thing ⟨whose price is⟩ four hundred *dīnāras* per *tola*, offer ⟨it⟩ to the goddess. In that case, what is the price of one *dhānakā*, one *aṇḍikā*, one *rakti*, one *yava*, one *kalā*, one *pāda*, and one *mūdṛkā* ⟨of the same thing⟩? Tell me.

$\frac{1}{1}$ *tola*, ⟨or⟩ 12 ⟨*dhānakās*⟩	price 400	1 *dhānakā*		
		1 *aṇḍikā*		
		4		
		1 *rakti*,	1:	divisor
			$\frac{1}{4}$	
		1 *yava*,	3:	divisor
			$\frac{1}{5}$	
		1 *kalā*,	6:	divisor
			$\frac{1}{4}$	
		1 *pāda*		
		4		
		1 *mūdṛkā*		
		4		

Result: 50 *dīnāras* ⟨and the remainder, which is⟩, since 12 *dhāṇas* = 1 *dīnāra*, 10 *dhāṇas*, ⟨and the remainder, which is⟩, since 4 *aṇḍikās* = 1 *dhāṇa*, 1 *aṇḍikā*. ...

X 3 (55^r)

⟨*Example 3 for Sūtra C10.*⟩

... one *pāda* and one *mūdṛkā*. ...

$\frac{1}{1}$ *tola*	5 *vajjaras*	1 *tola*	
	$\frac{1}{3}$	1 *dhānakā*	
		12	
		1 *aṇḍikā*	
		4	
		1 *rakti,*	1: divisor
			$\frac{1}{4}$
		1 *yava,*	3: divisor
			$\frac{1}{5}$
		1 *siddhārtha,*	2: divisor
			$\frac{1}{2}$
		1 *kalā,*	2: divisor
			$\frac{1}{2}$
		1 *pāda*	
		4	
		1 *mūdṛkā*	
		4	

Result: 6 *vajjaras*, 7 *pālāhatas*, 2 *śvetikās*, and the remainder $\frac{9}{10}$.[44] All ⟨terms⟩ of this ⟨enclosure are mutually⟩ multiplied: $\frac{7227}{1200}$. Now, one *vajjara* comprises six *drammas*, one *dramma* two *dhānakās*, and one *dhānakā* twenty-seven *pālāhatās*.

Of this ⟨third⟩ section ⟨of the enclosure, another expression may be employed⟩.

$\frac{1}{1}$ *tola*	5 *vajjaras*	$\frac{1}{1}$ *tola*; $\frac{1}{1}$ *dhānakā*, $\frac{1}{12}$; $\frac{1}{1}$ *aṇḍikā*, $\frac{1}{48}$; $\frac{1}{1}$ *rakti*, $\frac{1}{60}$;
	$\frac{1}{3}$	

$\frac{1}{1}$ *yava*, $\frac{1}{192}$; $\frac{1}{1}$ *siddhārtha*, $\frac{1}{480}$; $\frac{1}{1}$ *kalā*, $\frac{1}{1200}$; $\frac{1}{1}$ *pāda*, $\frac{1}{4800}$; $\frac{1}{1}$ *mūdṛkā*, $\frac{1}{19200}$

X 4 (55^v)

. . . , the remainder $\frac{1}{40}$.

44 This 'result' should come after the statement of the change-ratios that follows.

Example ⟨4 for Sūtra C10⟩.

... When the price of one *tolaka* is thirty-five *drammas*, what is the price of one and a half *tolakas*, one and a half *māṣakas*, one and a half *aṇḍikās*, and one and a half *yavas*?

Statement

$\frac{1}{1}$ *tola*	$\frac{35}{1}$	1	*tolas*	
		$\frac{1}{2}$		
		1	*māṣakas,*	$\frac{1}{6}$
		$\frac{1}{2}$		
		1	*aṇḍikās,*	$\frac{1}{2}$
		$\frac{1}{2}$		
		1	*yavas,*	$\frac{1}{2}$
		$\frac{1}{2}$		

Result: 58 *drammas* and the remainder $\frac{31}{128}$.

Again, another ⟨expression of the third term of the *trairāśika*⟩:

$\frac{1}{1}$ *tola*	$\frac{1}{35}$	1; 1, $\frac{1}{12}$; 1, $\frac{1}{48}$; 1, $\frac{1}{192}$
		$\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$

Result: 58 *drammas* and the remainder $\frac{31}{128}$.

Also, another ...

X 5 (20ʳ)

...

⟨Example 5 for Sūtra C10.⟩

For this same problem, another rule is applied.

1 $\frac{20}{1}$ *raktis*	$\frac{1}{1}$	*dhāṇa*	$\frac{1}{1}$ *suvarṇa,* $\frac{1}{1}$ *rakti*
$\frac{1}{4}$	0	*aṇḍikā*	factor: 80 *raktis* = 1 *suvarṇa*
	4	*yavas*	
	$\frac{1}{4}$		

Result: 4 *dhāṇas*, 1 *yava*, 3 *kalās*, 3 *pādas*, and 1 *mūdṛkā*.

⟨Example 6 for Sūtra C10.⟩

Also, ⟨computation⟩ of the third ⟨part of the same problem?⟩.

2 $\frac{20}{1}$	$\frac{1}{3}$		$\frac{1}{1}$ $\frac{1}{1}$	Upper factor:
$\frac{1}{4}$	$\frac{1}{2}$ $\frac{1}{2}$	factor: $\frac{1}{2}$		6 *dhāṇas* = 1 *dra⟨ṅkṣaṇa⟩*
	$\frac{1}{4}$	factor: $\frac{1}{4}$		

Result: 4 *dhāṇas*, 1 *yava*, 1 *kalā*, 2 *pādas*, and 1 *mūdṛkā*.

The measurement of gold ends.

Example ⟨7 for Sūtra C10⟩.

Thirteen and five-ninths days ... producing(?) ... *rāśis*[45]?

X 6 (20^v)

⟨Example 8 for Sūtra C10.⟩

...

$\frac{64}{1}$	$\frac{1}{1}$ year	$\frac{1}{1}$ *yojana*, factor: $\frac{768000}{1}$ *aṅgulas* = 1 *yojana*

Result: 12000 years.

Example ⟨9 for Sūtra C10⟩.

A serpent, eighteen *hastas* long, enters ⟨a hole⟩ at the speed of a half *aṅgula* plus ⟨its⟩ one ninth ⟨per day⟩, and goes backwards by a twenty-first ⟨of an *aṅgula*⟩ every day. In what time is the hole reached ⟨by the tip of the serpent's tail⟩?

$\frac{1}{2}$	$-$	$\frac{1}{21}$	$\frac{1}{1}$ $\frac{360}{1}$	$\frac{18}{1}$, factor: $\frac{24}{1}$ *aṅgulas* = 1 *hasta*
$\frac{1}{9}$				

Result: 2 years, 4 months, 10 days, and 15 *muhūrtas*.

⟨Example 10 for Sūtra C10.⟩

A worm is said ⟨to make⟩ half an *aṅgula* a day. ... In what time ... half of fifty ... ?

X 7 (33^r)

⟨Example 11 for Sūtra C10.⟩

... by nine and a half ...

45 Is this the measure of arc, equivalent to 30 degrees?

… 9	$\frac{1}{1}$ *vā*, factor: $\frac{9}{1}$ *gu* = 1 *va*
$\frac{1}{2}$	

… 19 …

Example ⟨12 for Sūtra C10⟩.

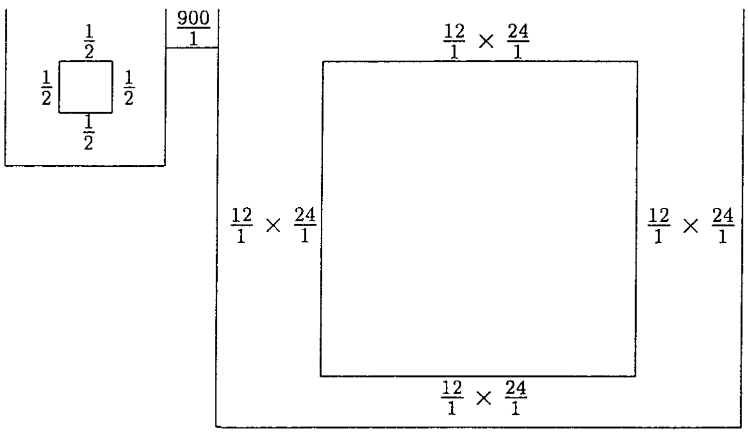
The *dīnāra* coin has indeed large wings. It is hard to earn and easy to spend. With one half of a half of a half of a half of a half of a half of it, a favour of one *guru* (spiritual teacher) ⟨is obtained⟩. ⟨How much is required for obtaining favours of one hundred and eight *gurus*?⟩

$\frac{1}{1}$	$\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$	$\frac{108}{1}$

Result: 1 *dīnāra*, 8 *dhāṇas*, and 1 *aṇḍikā*. This much of a petty sum is spent ⟨even for one hundred and eight *gurus*⟩.

⟨*Example 13 for Sūtra C10.*⟩

There are nine hundred hairs ⟨on a square skin whose⟩ breadth is a half of an *aṅgula*. How many hairs are there on a ⟨square⟩ skin of twelve *hasta* length? Let it be told.



Result: 298598400 hairs. …

X 8 (33^v)

⟨*Example 14 for Sūtra C10.*⟩

…

$\frac{1}{1}$ *pāda*	$\frac{1}{1}$ $\frac{1}{360}$	$\frac{12}{1}$ *ghaṭakas*, factor: $\frac{3360}{1}$ *pādas* = 1 *ghaṭaka*

Result: 112 years.

Example ⟨15 for Sūtra C10⟩.

The beautiful mount Meru, the pillar of the earth, is the best abode of the gods. A certain man climbed energetically the dwelling place of the gods. He goes all the while at the constant ⟨daily⟩ speed of seven and a half *yojanas* increased by a quarter, decreased by a half, and increased by a third and three fifths. The height ⟨of Meru⟩ is eighty-four thousand *yojanas*. In what time would he reach ⟨the top⟩? Say it to me exactly.

Statement:

7	⟨*yojanas*⟩	$\frac{1}{1}$ day	$\frac{84000}{1}$ *yojanas*
$\frac{1}{2}$			
$\frac{1}{4}$			
$-\frac{1}{2}$			
$\frac{1}{3}$			
$\frac{3}{5}$			

Lower factor:

360 days = 1 year

Result: 23 years and 4 months.

X 9 (32^r)

⟨Example 16 for Sūtra C10.⟩

... Sītā, whose face resembles the moon. She was carried off by Rāvaṇa to the sky half of sixty *yojanas* high. Sītā, getting rid of her own fear, dropped her garment from the sky. It turns back repeatedly: while falling downwards by one and a fifth *dhanus*, it is lifted up by the wind by one tenth ⟨of a *dhanus*⟩. Thus losing constantly ⟨its speed⟩ by that amount, ⟨it approaches the surface of the earth⟩. When it reaches the earth, how many turning-backs should there be? O ascetic, tell ⟨me⟩.

$1 - \frac{1}{10}$ *dhanus*	$\frac{1}{1}$ turning-back	$\frac{30}{1}$ *yojanas*, factor:
$\frac{1}{5}$		$\frac{8000}{1}$ ⟨*dhanus*⟩ = 1 *yojana*

Result: 218181 turning-backs and the remainder $\frac{9}{11}$.

Example ⟨17 for Sūtra C10⟩.

A snake, moving according to its own will, ... the fatal spot of a scorpion(?) ...

X 10 (32^{v})

⟨*Example 18 for Sūtra C10.*⟩

> . . . [46]

$\frac{1}{2}$ ⟨*aṅgula*⟩	$\frac{1}{1}$ ⟨day⟩	100	⟨*yojanas*⟩
		6	⟨*krośas*⟩
		8	
		3	⟨*hastas*⟩
		4000	
		5	⟨*aṅgulas*⟩
		24	

Upper factor: $\frac{768000}{1}$ *aṅgulas* = 1 *yojana*. Lower factor: 360 ⟨days = 1 year⟩. Result: 429867 years, 1 month, and 4 days.

Example ⟨*19 for Sūtra C10*⟩.

> A garment, released from ⟨the highest point of⟩ the Brahmaloka ('Brahman's World'), falls to the surface of the earth ⟨at the speed of⟩ three hundred less seven *yojanas* ⟨a day⟩. ⟨The height of the starting point is⟩ fourteen *koṭis* plus sixty-five *niyutas* ⟨of *yojanas*⟩ (i.e., 146,500,000 *yojanas*). How many days does it take ⟨for the garment⟩ to reach the surface of the earth? Tell ⟨me⟩, best of calculators!

Statement is made. . . .

X 11 (36^{r})

⟨*Example 20 for Sūtra C10.*⟩

> . . . fourteen . . . five times three, O friend!

$\frac{10}{1}$	$\frac{14}{1}$	$\frac{15}{1}$

Result: 21 *krośas*. This ⟨value⟩ has been obtained as a distance.[47]

⟨*Example 21 for Sūtra C10.*⟩

> . . . A mass of salt is cut into eight parts of an equal quantity by means of saws, and each of those lumps ⟨obtained⟩ is again divided into seven ⟨equal parts⟩. Each one of the seven lumps weighs one thousand and seventy-five ⟨*palas*⟩. What would be ⟨the weight of⟩ the seven times eight ⟨lumps⟩ (i.e., of the original mass of salt)?

46 The extant passage is too mutilated to be translated, but probably Example 18 = Example 17.

47 Or, 'Thus ends ⟨a section on⟩ distance.'

$\frac{1}{1}$ lump	$\frac{1075}{1}$	$\frac{56}{1}$	Lower factor: 2000 *palas* = 1 *bhāra*.

Result: 30 *bhāras* and 200 *palas*. This quantity is the amount of ⟨the original mass of⟩ salt.

⟨*Example 22 for Sūtra C10.*⟩

A certain man donates ⟨every day⟩ a hundredth of a twentieth of an eighteenth of a tenth of one *kākiṇī*. What will he donate in one hundred years? Tell ⟨me⟩, O learned one!

X 12 (36^v)

To the upper right corner: ... 1 *yava*, 1 *kalā*, 1 *pāda*, ...

To the left of a large knot:

⟨*Example 23 for Sūtra C10.*⟩

... The female worm ⟨goes⟩ three *yavas* ⟨a day⟩. O friend! In what ⟨time⟩ does she make five *yojanas*?

Statement is made:

$\frac{3}{1}$ *yavas*	$\frac{1}{1}\ \frac{1}{360}$	$\frac{5}{1}$ *yojanas*, factor: $\frac{4608000}{1}$ *yavas* = 1 *yojana*

Result: 21333 years and 4 months.

Example ⟨*24 for Sūtra C10*⟩.

A ship sails a half of a third of a *yojana* increased by a third and decreased by a quarter, per one third of a day increased by a third. She, however, being struck by the violent force of the wind, goes backwards by a half of a fifth plus an eighth of a *yojana*, per three days. In what time does she make one hundred and eight *yojanas*?

$\frac{1}{3}$ day: divisor,	$\frac{1}{3}$	times $\frac{1}{2}$	$-(\frac{1}{5}\ \frac{1}{2}) - \frac{1}{8}$, 3 ⟨days⟩: divisor	$\frac{1}{1}$	$\frac{108}{1}$
$\frac{1}{3}$	$\frac{1}{3}$	$-\frac{1}{4}$			

Lower factor: 360 days = 1 year. Result: 1 year.

X 13 (34^r)

⟨*Example 25 for Sūtra C10.*⟩

... grain ... of a man seeking another's welfare. One *prasṛti* ⟨of the grain⟩ is eaten by eleven birds. Tell ⟨me⟩, friend (male), how many birds ⟨eat⟩ eight *khārīs*. Tell ⟨me⟩, O lovely lady!

$\frac{1}{1}$ *prasṛti*	$\frac{11}{1}$ birds	8 *khārīs*, factor: 720 ⟨*prasṛtis* = 1 *khārī*⟩

Result: 63360 birds. So many ⟨birds can eat⟩.

Example ⟨26 for Sūtra C10⟩.

A certain man is said to have donated one *yava*, one *kalā*, and one *pāda* of gold to Śūlin (Śiva) on the head(?) every day . . . I want to know exactly how great an amount ⟨of gold⟩ he donated to Śarva (Śiva) in five years, one month, and fifteen days.

$\frac{1}{1}$ day	1 ⟨*yava*⟩		5	⟨years⟩, factor: 360
	1 ⟨*kalā*⟩	6: divisor	1	
		$\frac{1}{4}$	12	
	1 ⟨*pāda*⟩		15	
	4		30	

Lower factor: 192 *yavas* = 1 *tola*. Result: 11 *tolas*, 6 *dhāṇas*, 1 *aṇḍikā*, and 2 *yavas*.

X 14 (34^v)

⟨*Example 27 for Sūtra C10.*⟩

. . . increased(?) . . . by those having striped bodies. They injure(?) the greedy . . . with so many arrows ⟨shot⟩ by Arjuna . . .

$\frac{1}{80}$	$\frac{1}{1}$ arrow	$\frac{7}{2}$ $\frac{7}{2}$ $\frac{7}{2}$ $\frac{1}{7}$ *yojanas*, factor: $\frac{8}{1}$ ⟨*krośas* = 1 *yojana*⟩
$\frac{1}{9}$		
$\frac{1}{5}$		

Result: 2940 arrows.

⟨*Example 28 for Sūtra C10.*⟩

A diamond of one and a half *kuḍavas* plus half a *māṣaka* is obtained for fifty-five *sateras*. Tell ⟨me⟩ then the price of ⟨a diamond which weighs⟩ one fourth of a *māṇa* plus one fifteenth of a *siddhārtha*.

1 *kuḍavas*, factor: $\frac{128}{1}$ *māṣas* = 1 *kuḍava*, $\frac{1}{2}$ *māṣa*,
$\frac{1}{2}$

factor: 40 *siddhārthas* = 1 *māṣa*	$\frac{55}{1}$ *sateras*

... Upper factor: ...

X 15 (37^r)

⟨*Example 29 for Sūtra C10.*⟩

> ... ⟨The sun⟩, with a chariot, will traverse half of one hundred *koṭis* of *yojanas* (i.e., 5×10^8 *yojanas*) ⟨a day⟩. ... Tell me exactly. What is the ⟨distance⟩ traversed by the sun purified ... in one *ghaṭikā*?

$\frac{30}{1}$ *muhūrtas*, factor: $\frac{2}{1}$ *ghaṭikās* = 1 *muhūrta*	$\frac{500000000}{1}$	$\frac{1}{1}$ *ghaṭikā*

Result: 8333333 *yojanas* and the remainder $\frac{1}{3}$.

⟨*Example 30 for Sūtra C10.*⟩

> The chariot of the sun is surrounded by a flock of gods, Mahoragas, Siddhas, and Vidyādharas. That chariot will traverse half of one hundred *koṭis* ⟨of *yojanas*⟩ in a day and a night. Tell ⟨me⟩ then how far it would traverse in one *muhūrta*. You are versed in the science ⟨of computation⟩ and skillful in speech. Tell me, O best of calculators!

$\frac{30}{1}$ *muhūrtas*	$\frac{500000000}{1}$	$\frac{2}{1}$ *ghaṭikās*

Result: 16666666 *yojanas* and the remainder $\frac{2}{3}$.

X 16 (37^v)

⟨*Example 31 for Sūtra C10.*⟩

> ...

$\frac{1}{1}$ year	$\frac{1}{1}$ *rāśi*	$\frac{1}{1}$ day

Factor: $\frac{1}{360}$ ⟨year = 1 day⟩.

... one degree ... Thirty degrees make one *rāśi*. Upper factor: 108000 *viliptās* = 1 *rāśi*. Result: 5 *liptās*.

⟨*Example 32 for Sūtra C10.*⟩

> If Saturn traverses one *rāśi* in a half of five years, how far ⟨does it travel⟩ in a whole day? Tell ⟨me⟩, calculator. O truth-knower!

2 $\frac{1}{2}$	$\frac{1}{1}$ *rāśi*	$\frac{1}{1}$, factor: $\frac{1}{360}$ ⟨year = 1 day⟩

Upper factor: 108000 *viliptās* = 1 *rāśi*. Lower factor: $\frac{60}{1}$ *viliptās* = 1 *liptā*. Result: 2 *liptās*. This is the motion of the planet ⟨Saturn⟩.[48]

48 Or, 'This is ⟨a section on⟩ the motion of the planets.'

Example ⟨33 for Sūtra C10⟩.

King Yudhiṣṭhira, born in the family of Pāṇḍu, indeed ... every day ...

X 17 (41^v)

⟨Example 34 for Sūtra C10.⟩

... One should ... Regarding the lower(?), a rule is to be declared. ... 'Computation should be made from the top ⟨of the column⟩' ⟨Sūtra Q6⟩:

$\frac{17}{2}$
$\frac{1}{3}$

'One should have its divisor given to the ⟨numerator of the⟩ lower ⟨fraction⟩' ⟨Sūtra Q6⟩. ⟨In the present case⟩, one should have two, 2, given ⟨to the numerator, 1, of the $\frac{1}{3}$⟩. Given:

$\frac{17}{2}$
$\frac{2}{3}$

'Having multiplied ⟨separately the numerator and the denominator of⟩ the upper ⟨fraction⟩ by the ⟨denominator of the⟩ lower ⟨fraction⟩' ⟨Sūtra Q 6⟩. One should multiply the upper two terms by three:

$\frac{51}{6}$
$\frac{2}{3}$

'He should add the numerator ⟨of the lower fraction⟩ to the top' ⟨Sūtra Q6⟩. Addition 'to the top', i.e., to fifty-one, is made: $\frac{53}{6}$

... Statement:

$\frac{1}{1}$	$\frac{53}{6}$	$\frac{2}{1}$ *drammas*

Result: 17 *ā's* and 2 *tṛ's*.[49]

X 18 (41^r)

⟨Example 35 for Sūtra C10.⟩

... is made. ... How much is the ⟨total⟩ stipend for seventy men?

If ⟨the stipend⟩ of a man for forty-two days is eight *drammas*, then how much is ⟨the stipend⟩ of seventy men ⟨for the same period⟩?

Of a man for $\frac{42}{1}$ days	$\frac{8}{1}$ *drammas*: stipend	$\frac{70}{1}$ men for $\frac{42}{1}$ days

49 The abbreviations, *ā* and *tṛ*, have not been identified.

Result: *560 drammas.*

If five hundred and sixty *drammas* are for forty-two days, then how many days ⟨can the seventy men live⟩ on eight *drammas*? Tell me quickly.

$\frac{560}{1}$ *drammas*	$\frac{42}{1}$ days	$\frac{8}{1}$ *drammas*

Upper factor: 30 *muhūrtas* = 1 day. Result: 18 *muhūrtas.*

X 19 (65ʳ)

. . .

. . .	$\frac{\square 5}{1}$

In this time the seventy men arrive at the equivalence of their income and expense.

Another problem. ⟨*Example 36 for Sūtra C10*⟩.

> When the maintenance of a man for thirty days is six *drammas,* it should be calculated how many days are proposed for maintaining seventy honest watchmen(?) with six *drammas.*

Computation. First of all, if the maintenance of a man for thirty days is six *drammas,* then how much is ⟨the maintenance⟩ of seventy men?

$\frac{1}{1}$ man, $\frac{6}{1}$ *drammas*	30 days	$\frac{70}{1}$ men

Result: 350 *drammas.*

⟨Second:⟩ if three hundred and fifty *drammas* are . . .

X 20 (48ʳ)

⟨*Example 37 for Sūtra C10.*⟩

. . . How much . . . ?

1 day	1 *rakti*	loss: $-\frac{1}{8}$	$\frac{30}{1}$	years,	factor: 360
	1 *yava*	3: divisor $\frac{1}{3}$	$\frac{1}{3}$		
		$\frac{1}{5}$	1	month	
	1 *kalā*	6: divisor	12		
		$\frac{1}{4}$	1	day	
	1 *pāda*		30		
	4				
	$\frac{1}{3}$: remainder				

Factor: 480 *raktis* = 1 *pala*. All ⟨terms are mutually⟩ multiplied; the result is $\frac{4199421}{115200}$ ⟨*palas*⟩. Divided: 36 *palas* ⟨and the remainder, which is⟩, since 8 *tolas* = 1 *pala*, 3 *tolas* ⟨and the remainder, which is⟩, since 12 *dhāṇas* = 1 *tola*, 7 *dhāṇas* ⟨and the remainder, which is⟩, since 4 *aṇḍikās* = 1 *dhāṇa*, 2 *aṇḍikās* ⟨and the remainder, which is⟩, since ... = 1 *aṇḍikā*, ...

X 21 (48^v)

⟨*Example 38 for Sūtra C10.*⟩

$\frac{1}{1}$ man	5 *palas*	$\frac{80000}{1}$ men
	3 *tolas*	
	8 divisor	
	2 *dhāṇas*	
	12 divisor	
	3 *guñjās*	
	5 divisor	
	2 *yavas*, 3: divisor	
	$\frac{1}{5}$	

Lower factor: 2000 ⟨*palas* = 1 *bhāra*⟩. Result: 216 *bhāras* ⟨and the remainder, which is⟩ since 2000 *palas* = 1 *bhāra*, 270 *palas* ⟨and the remainder, which is⟩, since 8 *tolas* = 1 *pala*, 6 *tolas* ⟨and the remainder, which is⟩, since 12 *dhāṇas* = 1 *tola*, 8 *dhāṇas*.

If so much is given for one day, then how much is for twelve years? Statement:

$\frac{1}{1}$ day	216 *bhāras*	$\frac{12}{1}$ years, factor:
	270 *palas*	$\frac{360}{1}$ ⟨days = 1 year⟩
	2000 divisor	
	6 *tolas*	
	8 divisor	
	8 *dhāṇas*	
	12 divisor	

Result: 933705 *bhāras*. So much gold is begged.

Example ⟨*39 for Sūtra C10*⟩.

... for each *śiras* (head) ...

X 22 (47^v)

⟨*Example 40 for Sūtra C10.*⟩[50]

. . .

$\frac{1}{1}$ *śiras*	$\frac{15}{1}$ arrows	$\frac{10}{1}$ *śiras'*	Result: 150 ⟨arrows⟩.

Example ⟨*41 for Sūtra C10*⟩.

In a battle-array of Pārtha (Arjuna), Hehaya (Haihaya, Arjuna Kārtavīrya), and Kīcakanighna[51] (Bhīma), a *patti* was destroyed with sixteen arrows increased by its own quarter and by a half ⟨of the result⟩. O high-minded one! Four *akṣauhiṇīs* were defeated by him. You, expert in arms, tell ⟨me⟩ the number of arrows ⟨shot by him⟩.

$\frac{1}{1}$ *śiras*	$\frac{16}{1}$	$\frac{4}{1}$ *akṣauhiṇīs*, factor:
	$\frac{1}{4}$	$\frac{21870}{1}$ ⟨*śiras'* = 1 *akṣauhiṇī*⟩
	$\frac{1}{2}$	

Result: 2624400 arrows.

Another ⟨problem regarding⟩ the size of the *akṣauhiṇī*:

Example[52] ⟨*42 for Sūtra C10*⟩.

⟨An army composed of⟩ one chariot, one elephant, five men (or foot-soldiers), and three horses is called *patti* by those who know it. The wise call three times this *patti* *senāmukha*. Three[53]

X 23 (47^r)

senāmukhas[54] are said to be one *gulma*, three *gulmas* one *gaṇa*, and three *gaṇas* one *vāhinī*. Three *vāhinīs* have been regarded as a *pṛtanā* by the learned. Three *pṛtanās* make one *camū*, and three *camūs* one *anīkinī*. The wise call ten *anīkinīs* an *akṣauhiṇī*. ⟨This is⟩ the size of an *akṣauhiṇī*.

1 chariot	this	$\frac{3}{1}$ $\frac{3}{1}$ $\frac{3}{1}$ $\frac{3}{1}$ $\frac{3}{1}$ $\frac{3}{1}$ $\frac{3}{1}$ $\frac{10}{1}$: multiplied
1 elephant	is	
5 men	a	
3 horses	*patti*	

50 Probably, Example 40 = Example 39.
51 The restoration of this name is not certain, as it does not fit in the meter.
52 The word, *sūtraṃ* (a rule), in the manuscript must be a mistake.
53 To be continued on X 23.
54 Being continued from X 22.

Multiplied; the result is:

21870	chariots
21870	elephants
109350	men
65610	horses

This is the size of an *akṣauhiṇī*.

Example ⟨*43 for Sūtra C10*⟩.

A certain prince, Śatrudamana, . . .

X 24 (42^r)

⟨*Example 44 for Sūtra C10.*⟩

. . .

$\frac{20}{1}$	$\frac{160}{1}$ *rūpakas*	$\frac{6}{1}$
$\frac{1}{2}$		$\frac{1}{2}$
$\frac{1}{3}$		$\frac{1}{2}$

. . .

$\frac{40}{1}$	$\frac{160}{1}$	$\frac{\square}{1}$	
		$\frac{1}{\square}$	
			$\frac{\square}{\square}$

Result: 54 ⟨*rūpakas*⟩.

There, ⟨another rule⟩ is applied: six, increased by its own half and by a half ⟨of the result⟩, is thirteen and a half.

$\frac{40}{1}$ *bhāras*	$\frac{160}{1}$	13
		$\frac{1}{2}$

Result: 54 ⟨*rūpakas*⟩.

Or, divisions of these ⟨first two terms by forty⟩ are made; the result is: ⟨If⟩ four *rūpakas* are ⟨obtained⟩ by means of one ⟨*bhāra*⟩, then how much is ⟨obtained⟩ by means of thirteen and a half ⟨*bhāras*⟩?

$\frac{1}{1}$	$\frac{4}{1}$	$\frac{27}{2}$

Result: 54 ⟨*rūpakas*⟩.

By means of another's rule for these ⟨three quantities of the third term⟩: ⟨If⟩ four are obtained by means of one, how does ⟨the result⟩ come out of six?

$\frac{1}{1}$	$\frac{4}{1}$	$\frac{6}{1}$

Result: 24 ⟨*rūpakas*⟩.

Also — ⟨If⟩ one gets four, how much would be for a half of six itself?

$\frac{1}{1}$	$\frac{4}{1}$	$\frac{3}{1}$	Result: 12 ⟨*rūpakas*⟩.

... produced from three(?) ...

$42^r F^1$: ...

1 *ā*	1 days,	1 ...
$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{\square}$

$42^r F^2$: ... multiple of its own quantity(?) ...
$42^r F^3$: ... expense ...

X 25 (42^v)

$\frac{1}{1}$	$\frac{4}{1}$	$\frac{9}{1}\ \frac{1}{2}$

...

$\frac{1}{1}$	$\frac{4}{1}$	$\frac{9}{2}$	Result: 18 ⟨*rūpakas*⟩.

The result is 54. ⟨That is, we obtain⟩ 24 by means of six, 12 from its own half, and 18 from a half ⟨of the sum of six and three⟩; the sum is 54 ⟨*rūpakas*⟩. This *sūtra* is the individual-price rule in the application of the *trairāśika*.

I will tell ⟨you⟩ another ⟨rule for the *trairāśika*⟩.

⟨*Example 1 for Sūtra Q11.*⟩[55]

How much is for twenty days?

The 'self'[56] is written down in the first division ⟨of the enclosure in⟩ another's rule for problems ⟨of the *trairāśika*⟩.

$\frac{20}{1}$	1	$\frac{1}{3}$
	$\frac{1}{2}$	

'One should multiply the middle term' ⟨Sūtra Q11⟩. Multiplied; the result is:

$\frac{20}{1}$	$\frac{3}{2}$	$\frac{1}{3}$

Division:

$\frac{20}{1}$	$\frac{1}{2}$	$\frac{1}{1}$

The division being made, the result produced is 10 *rūpakas*. ⟨This is⟩ the expense for twenty days. Here, this is the multiplier of the upper division(?).

I will write another rule ⟨for the *trairāśika*⟩.

---

55 The problem is incomplete.
56 *śveya* = Skt. *svīya*, which denotes the third term of a *trairāśika*, usually called *icchā* (requisition).

⟨*Sūtra N19.*⟩

... price ...

42^{v}F^1: ... Example. One ... thirteen ...

X 26 (50^v)

... One should multiply ... , and divide in the case of ⟨computation leading to⟩ one term (*ekarāśika*).

Example ⟨1 for Sūtra N19⟩.

One hundred pieces of tin are obtained for one *dramma*. How many are obtained for a half ⟨dramma⟩? Apply the mathematical procedure leading to a single term (*ekarāśika*).

for	1	*dramma*
	100	pieces of tin
	$\frac{1}{2}$	

Result: 50 ⟨pieces⟩.

Another example: ⟨*Example 2 for Sūtra N19*⟩.

Three are obtained for two and a half. How many are obtained for one and a half plus ⟨it's own⟩ half?

2
$\frac{1}{2}$
$\frac{3}{1}$
$\frac{3}{2}$
$\frac{1}{2}$

Sūtra ⟨*Q5*⟩.[57]

Having multiplied the upper by the lower, you reduce ⟨the fractions⟩ in order. One should multiply the upper by the lower. By the product of the middle term and ⟨the number of⟩ commodities, he should divide the ⟨number of the⟩ articles obtained. ...

57 This is apparently meant to be used for solving the example, but is not understood.

X 27 (50^{r})

. . .

$\frac{\square}{1}$	$\frac{\square}{\square}$
$\frac{1}{4}$	$\frac{\square}{4}$

⟨Mā⟩rtikāvatī . . . This ⟨book⟩ has been written[58] by the king of the mathematicians, a *brāhmaṇa*, the son of Chajaka, for the sake of Hasika, son of Vasiṣṭha, in order that it may ⟨also⟩ be used by his descendants.

> Mathematics stands at the top of all sciences. Mathematics, produced in the mundane world (*saṃsāra*) that has a beginning and end, is great. It was after the Creation that ⟨mathematics was⟩ to be generated by Śiva, the Supreme Spirit.[59] Mathematics that was produced, and that begins with(?) . . . , is based on numbers. . . .

58 *likhita*. See Introduction, Chap. 7.

59 Another interpretation: 'It was to be generated after the Creation by the auspicious ⟨Brahmā⟩, the Supreme Spirit.'

PART IV

Commentary

CHAPTER 15

Numbered Sūtras

This chapter contains the *sūtras* whose serial numbers have been identified. They are Sūtras 9–11, 13–17, (18), 19–29, and 50–58.

Sūtras 1–8
Missing (unidentified)

Sūtra 9 (III 1)

Remark:
No clue for restoration.

Sūtra 10 (III 1)
Begging

Type of problem:
The properties (x, y) of two persons (A, B) are not known. A begged B: "If you give me p, my total property will become a times as much as your remaining property." B in turn begged A: "If you give me q, my total property will become b times as much as your remaining property." How much is each of their properties?

$$x + p = a(y - p)$$

$$y + q = b(x - q)$$

Rule:

$$x = \frac{(a+1)(p+q)}{ab-1} + q$$

$$y = \frac{(b+1)(p+q)}{ab-1} + p$$

Remarks:
An example of this type is given in BG 93 = BG 136; the former is solved by means of *ekavarṇa-samīkaraṇa* ('equations with one unknown'), and the latter by means of *anekavarṇasamīkaraṇa*

('equations with more than one unknown'). GSS miśraka $251\frac{1}{2}$–$252\frac{1}{2}$ gives a rule for a more general case, where more than two persons are involved. GSS miśraka $253\frac{1}{2}$–$258\frac{1}{2}$ gives two examles for it. Cf. also GSS miśraka 233–237 for a similar problem.

Sūtra 11 (III 1–4)
The price of a jewel and the properties of merchants

Type of problem:
There are n merchants, who are buying a jewel. The price (y) of the jewel is equal to the sum of the b_i/a_i parts of the property (x_i) of the i-th merchant and the whole properties of the others for any i ($i = 1, 2, \cdots, n$). How much is the property of each, and what is the price of the jewel?

$$\frac{b_i}{a_i}x_i + (x_1 + x_2 + \cdots + x_{i-1} + x_{i+1} + \cdots + x_n) = y$$

for every i ($i = 1, 2, \cdots, n$).

Rule:
Let

$$\frac{a_i}{(a_i - b_i)} = \frac{A_i}{B}$$

for every i. Then, a set of solutions is obtained by taking:

$$x_i = A_i$$
$$y = (A_1 + A_2 + \cdots + A_n) - B$$

Remarks:
This is an indeterminate system of linear equations. The *sūtra* itself does not mention the computation of y, but in the two extant examples it is calculated according to the above formula.

An equivalent rule is given in PM A24.

Example 1 (III 1–3).

Given: $\frac{b_i}{a_i} = \frac{1}{i+1}$ ($i = 1, 2, 3, 4, 5$).

Solution: $\frac{A_1}{B} = \frac{120}{60}, \frac{A_2}{B} = \frac{90}{60}, \frac{A_3}{B} = \frac{80}{60}, \frac{A_4}{B} = \frac{75}{60}$, and $\frac{A_5}{B} = \frac{72}{60}$. Therefore, $x_1 = 120, x_2 = 90, x_3 = 80, x_4 = 75$, and $x_5 = 72$; and $y = (120 + 90 + 80 + 75 + 72) - 60 = 437 - 60 = 377$.

Verification: $y = \frac{120}{2} + 90 + 80 + 75 + 72 = 377$. $y = 120 + \frac{90}{3} + 80 + 75 + 72 = 377$. $y = 120 + 90 + \frac{80}{4} + 75 + 72 = 377$. $y = 120 + 90 + 80 + \frac{75}{5} + 72 = 377$. $y = 120 + 90 + 80 + 75 + \frac{72}{6} = 377$.

Example 2 (III 3–4).

Given: $\frac{b_1}{a_1} = -\frac{7}{12}, \frac{b_2}{a_2} = -\frac{3}{4}, \frac{b_3}{a_3} = -\frac{5}{6}$.

Solution: $\frac{A_1}{B} = \frac{924}{1463}, \frac{A_2}{B} = \frac{836}{1463}$, and $\frac{A_3}{B} = \frac{798}{1463}$. Therefore, $x_1 = 924, x_2 = 836$, and $x_3 = 798$; and $y = (924 + 836 + 798) - 1463 = 2558 - 1463 = 1095$.

Remark. Cf. PM A25 for a similar example.

Sūtra 12
Missing (unidentified)

Sūtra 13 (III 5–6)
Mutual exchange of commodities

Type of problem:
There are n merchants, the i-th of whom has a_i articles of a certain kind of commodity. When each of them has given away m articles out of his possession to each of the others, their properties become equal to each other. What is the unit-price (x_i) of each commodity, and how much is the amount (y) of the property of each after the exchange?

$$\{a_i - m(n-1)\}x_i + m(x_1 + x_2 + \cdots + x_{i-1} + x_{i+1} + \cdots + x_n) = y$$

for every i $(i = 1, 2, \cdots, n)$.

Rule:

$$x_i = \frac{(a_1 - mn)(a_2 - mn)\cdots(a_n - mn)}{a_i - mn}$$
$$y = \frac{a_1x_1 + a_2x_2 + \cdots + a_nx_n}{n}$$

Remarks:
This rule gives a set of integral solutions to the indeterminate system of equations. Its rationale may be made thus. The above equation can be rewritten:

$$(a_i - mn)x_i + m(x_1 + x_2 + \cdots + x_n) = y$$

for every i. Therefore, we have,

$$x_i = \frac{y - m(x_1 + x_2 + \cdots + x_n)}{a_i - mn}.$$

From this, by assuming

$$y - m(x_1 + x_2 + \cdots + x_n) = (a_1 - mn)(a_2 - mn)\cdots(a_n - mn),$$

we obtain the first formula. The second formula is obtained by taking the arithmetical mean of the original properties of the n merchants.

The same formula for x_i is given in GSS miśraka 163, L 101, and in PM A28.

Example 1 (III 5): mutual exchange of cattle.

Given: $n = 3, m = 1, a_1 = 7, a_2 = 9, a_3 = 10$.

Solution: $(7-3)(9-3)(19-3) = 4 \cdot 6 \cdot 7 = 168$. $x_1 = \frac{168}{4} = 42, x_2 = \frac{168}{6} = 28$, and $x_3 = \frac{168}{7} = 24$; and $y = \frac{7\cdot 42 + 9\cdot 28 + 10\cdot 24}{3} = 262$.

Example 2 (III 6): mutual exchange of grain.

Given: $n = 3, m = 1$ *prastha*, $a_1 = 4, a_2 = 5, a_3 = 6$ (in *prasthas*).

Solution: $(4-3)(5-3)(6-3) = 1 \cdot 2 \cdot 3 = 6$. $x_1 = \frac{6}{1} = 6, x_2 = \frac{6}{2} = 3$, and $x_3 = \frac{6}{3} = 2$ (per *prastha*); and $y = \frac{4\cdot6+5\cdot3+6\cdot2}{3} = 17$.

Remark. For similar examples, see GSS miśraka 164–166, L 102 = BG 98, and PM A29 (= GSS miśraka 164) and A30.

Sūtra 14 (III 6)

Remarks:

Not understood. The reference made in the text, which has lost the word indicating the folio number, may to (I 12), where occurs an Āryā *pāda* (Sūtra Q8), which is exactly the same as the first *pāda* of Sūtra 14.

Sūtra 15 (III 6–7)
Equation of journeys

Type of problem:

A certain man goes at the rate of v_1 per time-unit. When the time period t_1 has elapsed since his departure, another man starts and travels v_2 per time-unit. How long (t_2) does it take for the second man to travel the same distance as the first?

$$v_1 t_1 + v_1 t_2 = v_2 t_2$$

Rule:

$$t_2 = \frac{v_2 - v_1}{v_1 t_1}$$

Remarks:

The formula of this *sūtra* is erroneous. The extant exmaples are, however, solved according to the correct one:

$$t_2 = \frac{v_1 t_1}{v_2 - v_1}.$$

The original stanza, therefore, must have contained a word indicating the multiplication of the reciprocal (indicated by '*vibhaktaṃ*') of $v_2 - v_1$ by $v_1 t_1$ (e.g., '*guṇaṃ ca*' instead of '*tenaiva*').

The same problem is treated in Sūtra N5. Cf. also Sūtra C3. The correct formula for the same problem is given in AB 2.31, PG 65, GSS miśraka $326\frac{1}{2}$, and PM A3.

Example 1 (III 6).

Remark. Too mutilated to be restored. Two quantities are seen in the extant portion: one and a half *yojanas* and a hundred. The latter, which is followed by the word *haṃta*, seems to be a multiplier of another number that is lost.

Example 2 (III 7).

Given: $v_1 = 5$ *yojanas*/day, $v_2 = 9$ *yojanas*/day, $t_1 = 7$ days.

Solution: $t_2 = \frac{5\cdot7}{9-5} = \frac{35}{4}$ days.

Verification: by means of the *trairāśika* (Sūtra C10). The distance traveled by the first man $= v_1t_1 + v_1t_2 = v_1t_1 + T(1, v_1, t_2) = 5 \cdot 7 + T\left(1, 5, \frac{35}{4}\right) = 35 + \frac{175}{4} = \frac{315}{4}$ *yojanas*. The distance traveled by the second man $= v_2t_2 = T(1, v_2, t_2) = T\left(1, 9, \frac{35}{4}\right) = \frac{315}{4}$ *yojanas*.

Remark. For the notation $T(a, b, c)$ of the *trairāśika* or the so-called rule of three, see under Sūtra Ċ10 below.

Example 3 (III 7).

Given: $v_1 = 18$ *yojanas*/day, $v_2 = 25$ *yojanas*/day, $t_1 = 8$ days.

Solution (not given in the text): $t_2 = \frac{18 \cdot 8}{25-18} = \frac{144}{7}$ days.

Remark. For similar examples, see Example 2 given by Bhāskara for AB 2.31, PG 81–82, GSS miśraka $327\frac{1}{2}$, and PM A4.

Sūtra 16 (III 7–8)
Equation of journeys

Type of problem:
Two travelers start simultaneously and increases their daily distances in arithmetical progressions (the first terms a_i, the common difference d_i). In what time do the total distances each has traveled become equal to each other?

$$S_i = \left\{a_i + \frac{(n-1)d_i}{2}\right\} \cdot n \quad (i = 1, 2)$$
$$S_1 = S_2$$

Rule:

$$n = 2 \cdot \frac{a_1 - a_2}{d_2 - d_1} + 1$$

Remarks:
This formula is mathematically equivalent to that of Sūtra 17.

See Remarks under Sūtra 18 for the running note about the numbering of this *sūtra* written in (III 8).

The same formula is given in GSS miśraka $322\frac{1}{2}$.

Example 1 (III 7–8).

Given: As the problem and the 'Statement' for it are lost, the given numbers themselves are not known, but it is known from the extant solution and verification that the four numbers satisfy the conditions:

$$a_1 - a_2 = d_2 - d_1 = 2$$
$$a_1 + d_1 = a_2 + d_2 = 7$$

There are four possible combinations of positive integers that satisfy these conditions:

a_1	d_1	a_2	d_2
3	4	1	6
4	3	2	5
5	2	3	4
6	1	4	3

Solution: $n = 2 \cdot \frac{2}{2} + 1 = 3$.
Verification: by means of the 'Minus-One' method (Sūtra Q12). $S_1(3) = 21$, and $S_2(3) = 21$.
Remark. Cf. GSS miśraka $323\frac{1}{2}$ for a similar example.

Sūtra 17 (III 8)
Equation of journeys

Type of problem:
Exactly the same as that of Sūtra 16.

Rule:

$$n = \frac{2(a_1 - a_2)}{d_2 - d_1} + 1$$

Remark:
The present *sūtra* slightly rewrites the formula of Sūtra 16.

Example 1 (III 8).
Given: $a_1 = 2, d_1 = 3, a_2 = 3, d_2 = 2$ (probably *yojanas*/day).
Solution (lost): $n = \frac{2(2-3)}{2-3} + 1 = 3$ (days).

Sūtra 18 (restored)
Equation of properties

Type of problem:
Two men earn money according to arithmetical progressions. In what time will the properties each has obtained become equal to each other?

$$S_i = \left\{ a_i + \frac{(n-1)d_i}{2} \right\} \cdot n \quad (i = 1, 2)$$
$$S_1 = S_2$$

Rule:

$$n = \frac{2(a_1 - a_2)}{d_2 - d_1} + 1$$

Remarks:
The stanza for Sūtra 18 has been tentatively restored by me on the basis of Sūtra 17 (see Appendix A). Sūtra 18 has been either missed or deliberately omitted by the commentator due probably to its mathematical equivalence to Sūtras 16 and 17. This may be the reason the numbering of *sūtras* is corrupt at the end of Sūtra 16.

Example 1 (III 9).
Given: $a_1 = 5, d_1 = 6, a_2 = 10, d_2 = 3$ (no measures are found).
Solution: $n = \frac{2(5-10)}{3-6} + 1 = \frac{13}{3}$.

Verification: by means of the 'Minus-One' method (Sūtra Q12). $S_1(\frac{13}{3}) = 65$, and $S_2(\frac{13}{3}) = 65$.

Remarks. A fraction is admitted as the period of an arithmetical progression in this example as well as in Example 1 for Sūtra 21. Even irrational periods occur in Example 2 for Sūtra 19 and in Examples 1 to 4 for Sūtra N18. Fractional periods are admitted also by Śrīdhara (PG Ex. 9, Ex. 103, and Ex. 104–105) and by Mahāvīra (GSS kalāsavarṇa 22–53).

Śrīdhara also gives another interpretation of fractional periods of arithmetical progressions (PG 89–93), according to which the sum of the progression whose period is $n+p$ $(0 < p < 1)$ is defined as:

$$S'(n+p) = S(n) + p \cdot a_{n+1},$$

where a_{n+1} is the $(n+1)$-th term of the progression, and $S(n)$ the ordinary sum up to the n-th term:

$$S(n) = \left\{a + \frac{(n-1)d}{2}\right\} \cdot n.$$

As has been noticed by the anonymous commentator (PG, pp. 131–132),

$$S'(n+p) \neq S(n+p).$$

Sūtra 19 (III 9–13)
Equation of journeys

Type of problem:
A certain man goes at the rate of v per time-unit. Another starts when the time period t_1 has elapsed since the departure of the former, and increases his speed by the arithmetical progression whose first term and common difference are a and d respectively. How long (t_2) does it take for the second man to travel the same distance as the first?

$$S_1(t_2) = vt_1 + vt_2$$
$$S_2(t_2) = \left\{a + \frac{(t_2-1)d}{2}\right\} \cdot t_2$$
$$S_1(t_2) = S_2(t_2)$$

Rule:

$$t_2 = \frac{\sqrt{\{2(v-a)+d\}^2 + 8\,vt_1d} + 2(v-a) + d}{2\,d}$$

Remarks:
The *sūtra* calls the value, $2(v-a)+d \ \ (= p)$, the *pratinihita* ('substituted'), and p^2 the *kṣepa* ('addendum').

Problems of this type always have one positive solution and one negative solution, but the present rule naturally accepts only the positive one.

Example 1 (III 10–11).
Given: $v = 5$ *yojanas*/day, $t_1 = 6$ days, $a = 3$ *yojanas*, $d = 4$ *yojanas*.

Solution: $p = 2(5-3)+4 = 8$. $8vt_1d = 8\cdot5\cdot6\cdot4 = 960$. $K = p^2 + 8vt_1d = 8^2 + 960 = 1024$. $t_2 = \frac{\sqrt{K}+p}{2d} = \frac{32+8}{8} = 5$ days.

Verification: by means of the *trairāśika* (Sūtra C10) and the 'Minus-One' method (Sūtra Q12). $S_1(5) = 5\cdot5 + T(1,5,5) = 30+25 = 55$, and $S_2(5) = \left\{3 + \frac{(5-1)\cdot4}{2}\right\}\cdot5 = 55$.

Remarks. The computation of $S_2(5)$ in the verification is lost. For the notation of the *trairāśika*, see under Sūtra C10 below.

Example 2 (III 11–13).

Given: $v = 7$ *yojanas*/day, $t_1 = 5$ days, $a = 5$ *yojanas*, $d = 3$ *yojanas*.

Solution: $p = 2(7-5)+3 = 7$. $8vt_1d = 8\cdot7\cdot5\cdot3 = 840$. $K = p^2+8vt_1d = 49+840 = 889$. An approximate value of $\sqrt{889}$ $(=\sqrt{K})$ is calculated according to Sūtra Q2. (See under Sūtra Q2 for the notation employed here.) $K = 889 = 29^2 + 48$. $p_1 = 29$, and $E = 48$. $p_2 = p_1 + \frac{E}{2p_1} = 29 + \frac{48}{58}$. Hence, $\sqrt{K} \approx 29\frac{48}{58}$, and $t_2 = \frac{\sqrt{K}+p}{2d} \approx \frac{29\frac{48}{58}+7}{6} = \frac{178}{29}(= t_2')$. The value of t_2' is then expressed in the sub-units of a day: $t_2' = 6$ days$+8$ *ghaṭikās*$+16$ *caṣakas*$+33$ *liptās*$+6\frac{6}{29}$ *viliptās*.

Verification: by means of the *trairāśika* (Sūtra C10) and the 'Minus-One' method (Sūtra Q12). Let $f = S_2 - S_1$, then what has to be shown is: $f(t_2) = S_2(t_2) - S_1(t_2) = 0$. Now, $f(t_2) = f(t_2') - e = S_2(t_2') - S_1(t_2') - e$, where e is the error caused by the approximtion of $\sqrt{K}$. Our text shows that $S_1(t_2')$ is equal to $\{S_2(t_2') - e\}$.

$$S_1(t_2') = 7\cdot5 + T\left(1, 7, \frac{178}{29}\right) = 35 + 42\frac{28}{29} = 77\frac{28}{29}$$
$$S_2(t_2') = \left\{5 + \frac{(\frac{178}{29}-1)\cdot3}{2}\right\}\cdot\frac{178}{29} = \frac{65593}{841}$$
$$e = \frac{E^2}{32p_1^2d} = \frac{48^2}{32\cdot29^2\cdot3} = \frac{24}{841}$$
$$S_2(t_2') - e = \frac{65593-24}{841} = \frac{65569}{841} = 77\frac{28}{29}$$

Remarks. The numerator, 24, of the error to be subtracted from that of S_2 is called 'a square' in the text, probably because it was a square number (48^2) before the reduction of the fraction. See under Sūtra Q2 for the root-approximation and the reconciliation process.

Sūtra 20 (III 14)
Equation of donations

Type of problem:
A certain man donates the amount a on the first day, and continues to donate that amount increased by d every succeeding day. Another donates the amount c every day. When will the total amounts each has donated become equal to each other?

$$S_1(t) = \left\{a + \frac{(t-1)d}{2}\right\}\cdot t$$
$$S_2(t) = ct$$
$$S_1(t) = S_2(t)$$

Rule:

$$t = \frac{c-a}{\frac{d}{2}} + 1$$

Remarks:
This formula is equivalent to those of Sūtras 21 and 23.

The same formula is given for problems of travelers in PG 96, GSS miśraka 319ab, and PM A6.

Example 1 (III 14).
Given: $a = 3$ *rūpakas*, $d = 4$ *rūpakas*, $c = 7$ *rūpakas*.
Solution: $t = \frac{7-3}{4/2} + 1 = 3$ days.
Verification: by means of the 'Minus-One' method (Sūtra Q12) and the *trairāśika* (Sūtra C10).
$S_1(3) = \left\{3 + \frac{(3-1)\cdot 4}{2}\right\} \cdot 3 = 21$ *rūpakas*, and $S_2(3) = T(1, 7, 3) = 21$ *rūpakas*.

Example 2 (III 14).
Given: $a = 1, d = 2, c = 5$ (no measures are found)
Solution (mostly lost): $t = \frac{5-1}{2/2} + 1 = 5$ days.
Remark. For similar examples, see GSS miśraka 320 and PM A5.

Sūtra 21 (III 15–16)
Equation of wages

Type of problem:
A certain man works for the wages a on the first day, and obtains the amount increased by d every succeeding day. Another earns the amount c every day. When will the properties each has obtained become equal to each other?

$$S_1(t) = \left\{a + \frac{(t-1)d}{2}\right\} \cdot t$$
$$S_2(t) = ct$$
$$S_1(t) = S_2(t)$$

Rule:

$$t = \frac{2c - 2a}{d} + 1$$

Remark:
This problem is equivalent to that of Sūtra 20, but the formula is rewritten in the present *sūtra*.

Example 1 (III 15–16).
Given: $a = 2$ *māṣakas*, $d = 3$ *māṣakas*, $c = 10$ *māṣakas*.
Solution: $t = \frac{2\cdot 10 - 2\cdot 2}{3} = \frac{16}{3}$ days.
Remark. For fractional periods of arithmetical progressions, see under Example 1 for Sūtra 18.

Sūtra 22 (III 16)
Distance to be covered by horses

Type of problem:
There is a chariot, to which n horses are yoked at a time. The number of horses is N in all, and the total distance to be covered is D. Each horse pulls the chariot for the same distance. What is that distance (d)?

$$\frac{d}{n} = \frac{D}{N}$$

Rule:

$$d = n \cdot \frac{D}{N}$$

Remark:
The same formula is given in GSS miśraka 157.

Example 1 (III 16).
Given: $N = 10, D = 100$ *yojanas*, $n = 5$.
Solution: $d = 5 \cdot \frac{100}{10} = 50$ *yojanas*.
Verification: $nD = 5 \cdot 100 = 500$. $d = T(N, nD, 1) = T(10, 500, 1) = 50$ *yojanas*.
Remark. For a similar example, see GSS miśraka 158. See under Sūtra C10 for the notation $T(a, b, c)$.

Sūtra 23 (III 17)
Equal division of gains

Type of problem:
The first person obtains the amount a of a certain thing, and the n-th person the amount $\{a + (n - 1)d\}$ of the same thing. They divide the total sum of their gains equally among themselves, with the result that the share of each is p. How many persons are there, and how much is the sum of their gains?

$$S(n) = \left\{a + \frac{(n-1)d}{2}\right\} n = pn$$

Rule:

$$n = \frac{2p - 2a}{d} + 1$$

Remarks:
The formula is identical with that of Sūtra 21, and equivalent to that of Sūtra 20.

An equivalent formula is given for the equal division of flowers in GSS miśraka 294, and other equivalents for the equal division of mangoes and fruits are found in PM A9 and A31.

Example 1 (III 17): gains of Brāhmaṇas.
Given: $a = d = 1, p = 10$.
Solution: $n = \frac{2 \cdot 10 - 2 \cdot 1}{1} + 1 = 19$. $S(19) = \left\{1 + \frac{(19-1) \cdot 1}{2}\right\} \cdot 19 = 190$.

Remark. For similar examples, see GSS miśraka 295 and PM A10 and A32.

Sūtra 24 (III 18–19)
Meeting of two travelers

Type of problem:
Two travelers go on a trip of distance D with the constant speeds v_1 and v_2 ($v_1 > v_2$) respectively. How long (t) does it take for the first person to meet the second on his return trip?

$$d_1(t) = v_1 t - D$$
$$d_2(t) = v_2 t$$
$$d_1(t) + d_2(t) = D$$

Rule:

$$t = 2 \cdot \frac{D}{v_1 + v_2}$$

Remarks:
The stanza, which is lost, has been restored on the basis of the solution of the extant example.

Equivalent formulas for the same type of problems are given in PG 66ab and GSS miśraka 319cd.

Example 1 (III 18).

Given: $v_1 = 6$ *yojanas*/day, $v_2 = 1$ *yojana*/day, $D = 70$ *yojanas*.

Solution: $t = 2 \cdot \frac{70}{6+1} = 20$ days.

Verification: $d_1(20) = T(1, 6, 20) - 70 = 120 - 70 = 50$ *yojanas*, and $d_2(20) = T(1, 1, 20) = 20$ *yojanas*. ⟨Hence $D = d_1(20) + d_2(20) = 70$ *yojanas*.⟩

Remark. For similar examples, see PG Ex. 83 and GSS miśraka $321\frac{1}{2}$. See under Sūtra C10 for the notation $T(a, b, c)$.

Sūtras 25 and 26 (III 19–32)
Smelting

Type of problem:
The original quantity (p) is decreased or increased successively by its own parts, the resulting amount being q.

$$q = p(1 + a_1)(1 + a_2) \cdots (1 + a_n),$$
$$q = p + s,$$

where each a_i is a fraction whose absolute value is less than unity, and s is the sum of the subtractive or additive quantities as the case may be.

Rule:
Sūtra 25:

$$q = p\{(1+a_1)(1+a_2)\cdots(1+a_n)\}$$
$$q = p + s$$

Sūtra 26:

$$p = \frac{q}{(1+a_1)(1+a_2)\cdots(1+a_n)}$$

Remarks:
The formula, as well as the stanza, of Sūtra 26 is restored from the extant three examples. The formula is certain, but the citation of stanza 26 is so fragmentary that it is difficult to restore it correctly.

The words, *dhānta* (= Skt. *dhmāta*, 'smelted') and *pārtha/pāstha/pāsta* (= Skt. *prāsta*, 'cast-out'), used in the rule suggest that the rule was originally meant for the smelting of metal, but, as is naturally expected, it is also applied to other problems of the same kind in some of the examples.

Fourteen examples for Sūtra 25 and three examples for Sūtra 26 exist. In some of the examples are employed other formuals derived from Sūtra 25.
Exs. 10–12 for Sūtra 25:

$$p = \frac{s}{(1+a_1)(1+a_2)\cdots(1+a_n)-1}$$

Ex. 13 for Sūtra 25:

$$p = \frac{p+q}{(1+a_1)(1+a_2)\cdots(1+a_n)+1}$$

Ex. 14 for Sūtra 25:

$$p = \frac{p-s}{2-(1+a_1)(1+a_2)\cdots(1+a_n)}$$

Quite often in the examples, s is calculated according to: $s = q - p$.

The expression, 'Having *subtracted* the cast-out ⟨fraction⟩ from unity,' of Sūtras 25 and 26 indicates that the *sūtras* themselves are meant for the case where $-1 < a_i < 0$ for every i. But the other cases are also noticed in the examples. Thus, the examples may be classified into three according to the signs of the a_i's.

	$(i = 1, 2, \cdots, n)$
Case A:	$-1 < a_i < 0$ for every i in
	Exs. 1–7, 10, 12–14 for Sūtra 25; Exs. 1–2 for Sūtra 26
Caṣe B:	$0 < a_i < 1$ for every i in
	Exs. 8, 11 for Sūtra 25
Case C:	$-1 < a_i < 0$ for some i's and $0 < a_i < 1$ for others in
	Ex. 9 for Sūtra 25; Ex. 3 for Sūtra 26

The value of q as is expressed in the first equation of this section is usually obtained by means of the algorithms called *bhāgāpavāhajāti* (partial-subtraction class) and *bhāgānubandhajāti* (partial-addition class). In our text, however, these algorithms are employed for the verification of answers. See below (5) *jātikriyā*.

The present section under Sūtras 25 and 26 is rich in verifications. For example, the answer to Ex. 1 for Sūtra 25 is verified in at least six different ways. I have identified the following seven methods of verification used in this section.

(1) *Trairāśika* (the rule of three)

The original quantity (p), or the remainder (q), or the loss (s) is calculated by means of the *trairāśika*.

$p = T\left(1, \dfrac{1}{(1+a_1)(1+a_2)\cdots(1+a_n)}, q\right)$	Ex. 1 for Sūtra 25
$p = T((1+a_1)(1+a_2)\cdots(1+a_n), 1, q)$	Ex. 2 for Sūtra 25
$q = T\left(\dfrac{1}{(1+a_1)(1+a_2)\cdots(1+a_n)}, 1, p\right)$	Ex. 1 for Sūtra 25
$p = T(s_0, p_0, s)$	Ex. 3 for Sūtra 25
$s = T(p_0, s_0, p)$	Ex. 3 for Sūtra 25
$p = T(p_0 + s_0, p_0, q)$	Ex. 2 for Sūtra 26

In the last three cases, the fraction, s_0/p_0, is the rate of the loss.

See under Sūtra C10 below for the *trairāśika* and the notation for it.

(2) Step-by-step method: Exs. 1, 4, and 5 for Sūtra 25.

The loss ($s_i < 0$) and the remainder (q_i) of each step are obtained successively by using the relations:

$$\begin{cases} s_1 = & a_1 p \\ q_1 = & p + s_1 \end{cases} \qquad \begin{cases} s_i & = a_i q_{i-1} \quad (i = 2, 3, \cdots, n) \\ q_i & = q_{i-1} + s_i \quad (i = 2, 3, \cdots, n) \end{cases}$$

Then, the values of q and s are obtained by:

$$q = q_n$$
$$s = s_1 + s_2 + \cdots + s_n.$$

(3) *Prastārakrama* ('the order in the tabular expression'): Exs. 4 and 6 for Sūtra 25.

The remainder (q) is obtained by multiplying p by $(1 + a_i)$ successively in 'the order of the tabular presentation' of those terms.

$$p \cdot (1+a_1) \cdot (1+a_2) \cdots (1+a_n) = q$$

This is expressed in the text thus:

p	1	1	$\cdots$	1	phalaṃ q //
	a_1	a_2	$\cdots$	a_n	

(4) *Iṣṭakarman* ('the computation with an optional number' or the so-called *regula falsi*): Exs. 1, 2, 4, and 9 for Sūtra 25, and Ex. 1 for Sūtra 26.

The original quantity (p) is here supposed to be unknown (see the statement '*mūlaṃ na jñāyate*' in III 26 and 30), and is computed by means of the *iṣṭakarman*, although this name itself does not occur in the text. That is, the equation,

$$x(a + a_1)(1 + a_2) \cdots (1 + a_n) = q,$$

is solved by supposing $x = 1$:

$$x = \frac{1 \cdot q}{1 \cdot (a + a_1)(1 + a_2) \cdots (1 + a_n)} = p.$$

This is expressed in the text thus:

$$\begin{array}{|ccccccc|l} 0 & 1 & 1 & \cdots & 1 & \text{bhā} & q & \quad \text{phalaṃ } p \text{ //} \\ 1 & a_1 & a_2 & \cdots & a_n & & & \\ \hline \end{array}$$

The figure zero in this expression indicates that p is unknown, and it is replaced by unity in the computation. The abbreviation, *bhā*, for *bhājita* (divided) or *bhāgahāra* (division or divisor), indicates the division of q by the product, $1 \cdot (1 + a_1)(1 + a_2) \cdots (1 + a_n)$. In actual computations, however, the '1' of the denominator and numerator would have been ignored.

In the second verification of Ex. 2 for Sūtra 25, where $n = 1$, the terms before *bhā* are arranged vertically:

$$\begin{array}{|c|cc|l} 0 & \text{bhā} & q & \quad \text{phalaṃ } p \text{ //} \\ 1 & & & \\ 1 & & & \\ a_1 & & & \\ \hline \end{array}$$

For the *iṣṭakarman*, see under Sūtras N8–N12 below.

(5) *Jātikriyā* ('the class-operaton'): Exs. 1, 4, 6, 8, 9, and 10 for Sūtra 25.

$$\frac{b}{a}\left(1 \pm \frac{d}{c}\right) = \frac{b(c \pm d)}{ac},$$

are usually called *bhāgānubandhajāti* ('partial-addition class') and *bhāgāpavāhajāti* ('partial subtraction class'). The left-hand side of this equation is, in those texts, expressed in a tabular form thus:

$$\begin{array}{c} b \\ a \\ \pm d \\ c \end{array}$$

where the plus sign is for the *bhāgānubandhajāti*, and the minus sign for the *bhāgāpavāhajāti*. See PG 39–40, Tr 24, GSS kalāsavarṇa 113 and 126, MS 15.11–12, SS 13.10, GT pp. 34–37, and L 34. Brahmagupta calls the two methods the fourth and the fifth classes respectively (BSS 12.9). In our text also, the word *pañcamajāti* ('the fifth class') is used to denote the *bhāgāpavāhajāti* (II 10 and III 19), although no name for the other is found in the extant manuscript.

I will call the two kinds of computation simply *jātikriyā* in the sense of the computation named *jāti* ('class').

As has been mentioned above, most Indian mathematical texts would employ *jātikriyā* in order to obtain the value of q in the first equation, that is, in order to solve the problem. In the present section under Sūtras 25 and 26, however, it is used for verifying the answer.

The terms, p and a_i, are arranged vertically, and the above rule is applied to the upper-most two terms of this column repeatedly.

$$\begin{array}{|c|} p \\ a_1 \\ a_2 \\ \cdot \\ \cdot \\ \cdot \\ a_n \\ \hline \end{array} \quad \text{phalaṃ } q \text{ //}$$

I will denote this computation by using a pair of square brackets:

$$[p\,; a_i] = q,$$

or

$$[p\,; a_1, a_2, \cdots, a_n] = q.$$

(6) *Iṣṭakarman* with *jātikriyā*: Exs. 1, 4, 6, 8, and 9 for Sūtra 25.

Just as in the case of (4) above, the original quantity (q) is supposed to be unknown, and is obtained by means of the *iṣṭakarman*. The only difference is that the value of the divisor,

$$1 \cdot (1 + a_1)(1 + a_2) \cdots (1 + a_n),$$

is here obtained not as the direct product of those $(n+1)$ terms but by means of the *jātikriyā*. Thus,

$$x = \frac{1 \cdot q}{[1; a_1, a_2, \cdots, a_n]} = p.$$

This equation may be explained by the identity,

$$[p\,; a_i] = p[1; a_i],$$

and the relationship,

$$q = [p\,; a_i].$$

In the text, the computation is expressed thus:

$$\begin{array}{|c|cc|} 0 & \text{bhā} & q \\ \cline{2-3} 1 & & \\ a_1 & & \\ a_2 & & \\ \cdot & & \\ \cdot & & \\ \cdot & & \\ a_n & & \\ \hline \end{array} \quad \text{phalaṃ } p \text{ //}$$

(7) Formula of Sūtra 25: Ex. 10 for Sūtra 25.

Ex. 10 requires p, when s and a_i are given. In its verification, the formula of Sūtra 25 itself is employed for obtaining the value of q, and this is combined with the relation, $q = p + s$, in order to arrive at s.

Example 1 for Sūtra 25 (III 19–20): smelting of a certain metal.

Given: $p = 108, a_1 = a_2 = a_3 = -\frac{1}{3}$.

Solution: $q = 108 \cdot \left(1 - \frac{1}{3}\right)^3 = 32$.

Verification 1: by steps.

smelting	loss	residue
1st	36	72
2nd	24	48
3rd	16	32

The last residue, 32, is q.

Verification 2: *iṣṭakarman.* $p = 32/\left(1-\frac{1}{3}\right)^3 = 32/\left(\frac{8}{27}\right) = 108.$

Verification 3: *jātikriyā.* $q = \left[108; -\frac{1}{3}, -\frac{1}{3}, -\frac{1}{3}\right] = 32.$

Verification 4: *iṣṭakarman* with *jātikriyā.* $p = 32/\left[1; -\frac{1}{3}, -\frac{1}{3}, -\frac{1}{3}\right] = 108.$

Verification 5: *trairāśika.* $q = T\left(1/\left(1-\frac{1}{3}\right)^3, 1, 108\right) = T\left(\frac{27}{8}, 1, 108\right) = 32.$

Verification 6: *trairāśika.* $p = T\left(1, 1/\left(1-\frac{1}{3}\right)^3, 32\right) = T\left(1, \frac{27}{8}, 32\right) = 108.$

Example 2 for Sūtra 25 (III 20–21): smelting of iron (*loha*).

Given: $p = 140, a_1 = -\frac{3}{10}.$

Solution: $q = 140 \cdot \left(1-\frac{3}{10}\right) = 98.$ $s = 98 - 140 = -42.$

Verification 1: *trairāśika.* $p = T\left(1-\frac{3}{10}, 1, 98\right) = T\left(\frac{7}{10}, 1, 98\right) = 140.$

Verification 2: *iṣṭakarman.* $p = 98/\left(1-\frac{3}{10}\right) = 98/\left(\frac{7}{10}\right) = 140.$

Example 3 for Sūtra 25 (III 21): loss in a purchase.

Given: $p = 18$ *palas*, $a_1 = s_0/p_0 = \left(-\frac{1}{3}\right)/\left(\frac{3}{2}\right) = -\frac{2}{9}$ (s_0/p_0 is the rate of the loss).

Solution: $q = 18 \cdot \left(1-\frac{2}{9}\right) = 14$ *palas*. $s = 14 - 18 = -4$ *palas*.

Verification 1: *trairāśika.* $s = T\left(\frac{3}{2}, -\frac{1}{3}, 18\right) = -4.$

Verification 2: *trairāśika.* $p = T\left(-\frac{1}{3}, \frac{3}{2}, -4\right) = 18.$

Example 4 for Sūtra 25 (III 21–22): smelting of gold.

Given: $p = 500$ *palas*, $a_1 = a_2 = a_3 = a_4 = -\frac{1}{4}.$

Solution: $q = 500 \cdot \left(1-\frac{1}{4}\right)^4 = 158\frac{13}{64}$ *palas* $= 158$ *palas* $+1\frac{1}{64}$ *tolas*.

Verification 1: *jātikriyā*.

$q = \left[500; -\frac{1}{4}, -\frac{1}{4}, -\frac{1}{4}, -\frac{1}{4}\right] = \frac{10125}{64} = 158$ *palas* $+ 1\frac{1}{64}$ *tolas*.

Verification 2: *iṣṭakarman* with *jātikriyā*.

$p = (158$ *palas* $+ 1\frac{1}{64}$ *tolas*$)/\left[1; -\frac{1}{4}, -\frac{1}{4}, -\frac{1}{4}, -\frac{1}{4}\right] = \left(\frac{10125}{64}\right)/\left(\frac{81}{256}\right) = 500$ *palas*.

Verification 3: *prastārakrama*.

$q = 500 \cdot \left(1-\frac{1}{4}\right) \cdot \left(1-\frac{1}{4}\right) \cdot \left(1-\frac{1}{4}\right) \cdot \left(1-\frac{1}{4}\right) = 158$ *palas* $+ 1\frac{1}{64}$ *tolas*.

Verification 4: *iṣṭakarman*

$p = (158$ *palas* $+ 1\frac{1}{64}$ *tolas*$)/\left(1-\frac{1}{4}\right)^4 = \left(\frac{10125}{64}\right)/\left(\frac{81}{256}\right) = 500$ *palas*.

Verification 5: by steps.

smelting	loss	residue
1st	125	375
2nd	$93\ \frac{3}{4}$	$281\ \frac{1}{4}$
3rd	$70\ \frac{5}{16}$	$210\ \frac{15}{16}$
4th	$52\ \frac{47}{64}$	$158\ \frac{13}{64}$

The measure used in this table is *pala*. The loss at the second smelting is expressed in the text as: 93 *palas* 3 *tolas* 9 *māṣas*. The last residue is q.

Example 5 for Sūtra 25 (III 23–24): dilution of honey with water.

Given: $p = 4$ *prasthas*, $a_1 = a_2 = a_3 = a_4 = -\frac{1}{4}$.

Solution: $q = 4 \cdot \left(1 - \frac{1}{4}\right)^4 = 4 \cdot \frac{81}{256} = \frac{81}{64}$ *prasthas* =1 *prastha*+$1\frac{1}{16}$ *kuḍavas*.

$s = \left(1 \textit{ prastha} + 1\frac{1}{16} \textit{ kuḍavas}\right) - 4 \textit{ prasthas} = -\left(2 \textit{ prasthas} + 2\frac{15}{16} \textit{ kuḍavas}\right)$.

Verification: by steps.

dilution	quantity drunk		quantity after dilution		
	honey	water	honey	water	total
1st	⟨4⟩	⟨0⟩	12	4	16
2nd	3	⟨1⟩	⟨9⟩	⟨7⟩	⟨16⟩
3rd	$2\frac{1}{4}$	$2 - \frac{1}{4}$	$7 - \frac{1}{4}$	$9\frac{1}{4}$	⟨16⟩
4th	$\langle 1\frac{11}{16} \rangle$	$\langle 2\frac{5}{16} \rangle$	$5\langle\frac{1}{16}\rangle$	$10\frac{15}{16}$	16

The measure here used is *kuḍava*: 4 *kuḍavas* =1 *prastha*. The numbers in the angle brackets are either lost or not given in the text. The last quantity of honey, $5\frac{1}{16}$ *kuḍavas*, is q.

Example 6 for Sūtra 25 (III 24–25): toll taxes on saffron.

Given: $p = 8$ (*palas*?), $a_1 = a_2 = a_3 = a_4 = -\frac{1}{4}$.

Solution: the prescribed rule of Sūtra 25 is here applied step by step in four successive stages.

toll station	remaining saffron	tax paid
1st	6	2
2nd	$4\frac{1}{2}$	$1\frac{1}{2}$
3rd	$3\frac{3}{8}$	$\langle 1\frac{1}{8} \rangle$
4th	$\langle 2\frac{17}{32} \rangle$	$\langle \frac{27}{32} \rangle$

The numbers in the angle backets are lost. The remaining saffron at the fourth toll station, $2\frac{17}{32}$ (*palas*?), is q.

Verification 1: *prastārakrama*. $q = 8 \cdot \left(1 - \frac{1}{4}\right) \cdot \left(1 - \frac{1}{4}\right) \cdot \left(1 - \frac{1}{4}\right) \cdot \left(1 - \frac{1}{4}\right) = \frac{81}{32}$.

Verifiaction 2: a variation of *prastārakrama*. $q = 8 \cdot \frac{3}{4} \cdot \frac{3}{4} \cdot \frac{3}{4} \cdot \frac{3}{4} = \frac{81}{32}$.

Verification 3: *jātikriyā*. $q = \left[8; -\frac{1}{4}, -\frac{1}{4}, -\frac{1}{4}, -\frac{1}{4}\right] = \frac{81}{32}$.

Verification 4: *iṣṭakarman* with *jātikriyā*.

$p = \left(\frac{81}{32}\right) / \left[1; -\frac{1}{4}, -\frac{1}{4}, -\frac{1}{4}, -\frac{1}{4}\right] = \left(\frac{81}{32}\right) / \left(\frac{81}{256}\right) = 8.$

Example 7 for Sūtra 25 (III 25): donation of malasses (*guḍa*).
Given: $p = 8$ *bhārakas*, $a_1 = -\frac{1}{3}, a_2 = -\frac{1}{6}, a_3 = -\frac{1}{5}$.
Solution: $q = 8 \cdot \left\{\left(1 - \frac{1}{3}\right)\left(1 - \frac{1}{6}\right)\left(1 - \frac{1}{5}\right)\right\} = \frac{32}{9}$ *bhārakas*.
Verification: not given.

Example 8 for Sūtra 25 (III 25–26): investment of grain.
Given: $p = 10$ *droṇas*, $a_1 = a_2 = a_3 = \frac{1}{4}$.
Solution: $q = 10 \cdot \left(1 + \frac{1}{4}\right)^3 = \frac{1250}{64}$ *droṇas* = 19 *droṇas* + 2 *āḍhakas* + 2 *kuḍavas*.
Verification 1: *jātikriyā*.
$q = \left[10; \frac{1}{4}, \frac{1}{4}, \frac{1}{4}\right] = \frac{625}{32} = 19$ *droṇas* + 2 *āḍhakas* + 2 *kuḍavas*.
Verification 2: *iṣṭakarman* with *jātikriyā*.
$p =$ (19 *droṇas* + 2 *āḍhakas* + 2 *kuḍavas*)/ $\left[1; \frac{1}{4}, \frac{1}{4}, \frac{1}{4}\right] = \left(\frac{625}{32}\right) / \left(\frac{125}{64}\right) = 10$ *droṇas*.

Example 9 for Sūtra 25 (III 26): profit and loss of a merchant.
Given: $p = 60, a_i = (-1)^i \frac{1}{i+1}$ $(i = 1, 2, 3, 4)$.
Solution: $q = 60 \cdot \left\{\left(1 - \frac{1}{2}\right)\left(1 + \frac{1}{3}\right)\left(1 - \frac{1}{4}\right)\left(1 + \frac{1}{5}\right)\right\} = 36.$
Verification 1: *iṣṭakarman*. $p = 36/\left\{\left(1 - \frac{1}{2}\right)\left(1 + \frac{1}{3}\right)\left(1 - \frac{1}{4}\right)\left(1 + \frac{1}{5}\right)\right\} = 60.$
Verification 2: *jātikriyā*. $q = \left[60; -\frac{1}{2}, \frac{1}{3}, -\frac{1}{4}, \frac{1}{5}\right] = 36.$
Verification 3: *iṣṭakarman* with *jātikriyā*. $p = 36/\left[1; -\frac{1}{2}, \frac{1}{3}, -\frac{1}{4}, \frac{1}{5}\right] = 60.$

Example 10 for Sūtra 25 (III 27): taxes in kind on a certain thing.
Given: $s = -24, a_i = -\frac{1}{i+2}$ $(i = 1, 2, 3)$.
Solution: $p = s/\{(1 + a_1)(1 + a_2)(1 + a_3) - 1\} = (-s)/\{1 - (1 + a_1)(1 + a_2)(1 + a_3)\} = 24/\left\{1 - \left(1 - \frac{1}{3}\right)\left(1 - \frac{1}{4}\right)\left(1 - \frac{1}{5}\right)\right\} = 24/\left(\frac{3}{5}\right) = 40.$
Verification 1: Sūtra 25. $q = 40 \cdot \left\{\left(1 - \frac{1}{3}\right)\left(1 - \frac{1}{4}\right)\left(1 - \frac{1}{5}\right)\right\} = 40 \cdot \frac{2}{5} = 16.$ $s = 16 - 40 = -24.$
Verification 2: *jātikriyā*. $q = \left[40; -\frac{1}{3}, -\frac{1}{4}, -\frac{1}{5}\right] = 16.$ $s = 16 - 40 = -24.$

Example 11 for Sūtra 25 (III 27–28): increase of molasses (*guḍa*).
Given: $s = 40, a_i = \frac{1}{i+2}$ $(i = 1, 2, 3, 4)$.
Solution (lost): $p = s/\{(1 + a_1)(1 + a_2)(1 + a_3)(1 + a_4) - 1\} = 40/\left(\frac{7}{3} - 1\right) = 30.$ $q = 30 + 40 = 70.$

Example 12 for Sūtra 25 (III 28): smelting of iron stone (*aṃśaloha*).
Given: $s = -27, a_i = -\frac{1}{i+2}$ $(i = 1, 2, 3)$.
Solution: by means of the same formula as in Ex. 10 above.
$p = 27/\left\{1 - \left(1 - \frac{1}{3}\right)\left(1 - \frac{1}{4}\right)\left(1 - \frac{1}{5}\right)\right\} = 27/\left(1 - \frac{2}{5}\right) = 27/\left(\frac{3}{5}\right) = 45.$ $q = 45 - 27 = 18.$
Verification: not given.

Example 13 for Sūtra 25 (III 28): smelting of waste iron (*parikṣīṇaloha*).
Given: $p + q = 20, a_i = -\frac{1}{i+2}$ $(i = 1, 2, 3)$

Solution (lost): $p = (p+q)/\{(1+a_1)(1+a_2)(1+a_3)+1\} =$
$20/\left\{\left(1-\frac{1}{3}\right)\left(1-\frac{1}{4}\right)\left(1-\frac{1}{5}\right)+1\right\} = \frac{100}{7}$. $q = 20 - \frac{100}{7} = \frac{40}{7}$. $s = \frac{40}{7} - \frac{100}{7} = -\frac{60}{7}$.

Example 14 for Sūtra 25 (III 29): smelting of a certain metal.
Given: $p - s = 32, a_i = -\frac{1}{i+2}$ $(i = 1, 2, 3)$
Solution: $p = (p-s)/\{2-(1+a_1)(1+a_2)(1+a_3)\}$
$= 32/\left\{1+1-\left(1-\frac{1}{3}\right)\left(1-\frac{1}{4}\right)\left(1-\frac{1}{5}\right)\right\} = 32/\left(1+1-\frac{2}{5}\right) = 32/\left(1+\frac{3}{5}\right)$
$= 32/\left(\frac{8}{5}\right) = 20$. $s = 20 - 32 = -12$.
Verification: not given.

Example 1 for Sūtra 26 (III 30): smelting of iron.
Given: $q = 16$ *palas*, $a_1 = a_2 = a_3 = a_4 = -\frac{1}{3}$.
Solution: $p = 16/\left(1-\frac{1}{3}\right)^4 = 16/\left(\frac{16}{81}\right) = 81$ *palas*.
Verification 1: The method here used is named *kalāsavarṇa* ('reduction of fractions to the same color') in the text, and probably the *jātikriyā* is meant by that term. The 'Statement' given in the text, however, is not that for the *jātikriyā* but that either for Sūtra 25 or for the *prastārakrama*. Thus, $q = 81 \cdot \left(1-\frac{1}{3}\right)^4 = 16$ *palas*.
Verification 2: *iṣṭakarman*. $p = 16/\left(1-\frac{1}{3}\right)^4 = 81$ *palas*.

Example 2 for Sūtra 26 (III 31): loss in a purchase.
Given: $q = 10, a_1 = s_0/p_0 = \left(-\frac{1}{3}\right)/\left(\frac{3}{2}\right) = -\frac{2}{9}$. ($s_0/p_0$ is the rate of the loss. Cf. Ex. 3 for Sūtra 25.)
Solution: $p = 10/\left(1-\frac{2}{9}\right) = 12\frac{6}{7}$.
Verification: *trairāśika*. $p = T(p_0+s_0, p_0, q) = T\left(\frac{7}{6}, \frac{3}{2}, 10\right) = 12\frac{6}{7}$.

Example 3 for Sūtra 26 (III 31–32): increase and decrease of honey.
Given: $q = 3$ *palas*, $a_i = (-1)^{i+1}\frac{2}{2i+1}$ $(i = 1, 2, 3, 4)$.
Solution: $p = 3/\left\{\left(1+\frac{2}{3}\right)\left(1-\frac{2}{5}\right)\left(1+\frac{2}{7}\right)\left(1-\frac{2}{9}\right)\right\} = 3$ *palas*.

Sūtras 27, 28, and 29 (III 32–36)
Impurity of gold

Type of problem:
There are n pieces of gold. The weight, purity, and impurity of the i-th piece are respectively w_i *suvarṇas*, v_i *māṣas/suvarṇa*, and k_i *māṣas/suvarṇa*. They are melted into a single alloy, whose weight, purity, and impurity are respectively W *suvarṇas*, V *māṣas/suvarṇa*, and K *māṣas/suvarṇa*.

Rule:
Sūtra 27:

$$K = \frac{k_1w_1 + k_2w_2 + \cdots + k_nw_n}{w_1 + w_2 + \cdots + w_n}$$

Sūtra 28:

$$k_i = \frac{KW - (k_1w_1 + \cdots + k_{i-1}w_{i-1} + k_{i+1}w_{i+1} + \cdots + k_nw_n)}{w_i}$$

Sūtra 29:

$$W = \frac{16(w_1 + w_2 + \cdots + w_n) - (k_1w_1 + k_2w_2 + \cdots + k_nw_n)}{16 - K}$$

Remarks:
The purity and impurity of a gold alloy are defined respectively as the weights in *māṣas* of pure gold and other metals contained in one *suvarṇa* of that alloy. Since one *suvarṇa* is equal to sixteen *māṣas* in our text as well as in most other texts, the purity of pure gold is 16; and we have the relations:

$$v_i + k_i = V + K = 16 \tag{15.1}$$

for every i.

In the case of a simple mixture, the total weight of metals other than gold, as well as that of pure gold, is preserved. Therefore, we have the relations:

$$VW = v_1w_1 + v_2w_2 + \cdots + v_nw_n \tag{15.2}$$
$$KW = k_1w_1 + k_2w_2 + \cdots + k_nw_n \tag{15.3}$$
$$W = w_1 + w_2 + \cdots + w_n \tag{15.4}$$

In the case of deterioration and refinement, however, only the total weight of pure gold is preserved. Therefore, out of the above three equations, only the first, (1.2), holds true.

Sūtra 27 is derived from (1.3) and (1.4). PG 52cd, Tr 36, MS 15.38cd, and L 103ab give the same formula for purity. GSS miśraka 169ab, in giving the same formula, uses the word *kṣaya* ('loss' or impurity in our text), but it seems to be used as a synonym of *varṇa* ('color' or purity) by Mahāvīra.

Sūtra 28 is derived from (1.3). PG 54, GSS miśraka $175\frac{1}{2}$–$176\frac{1}{2}$, MS 15.40, and L 106 give the same formula for purity.

Sūtra 29 is prescribed for the case of deterioration. It is derived from (1.1) and (1.2). Since, however, the *sūtra* itself does not specify the purity of pure gold, it is applicable in any weight system; thus, when $K + V = k_i + v_i = V_p \neq 16$, the '16' in the above formula is replaced by V_p.

An equivalent formula for purity in the case of refinement:

$$W = \frac{v_1w_1 + v_2w_2 + \cdots + v_nw_n}{V}$$

is given in PG 53 cd = Tr 37cd, MS 15.39cd, and L 103cd.

Example 1 for Sūtra 27 (III 32–33): a simple mixture.
Given: $w_i = i$ *suvarṇas*, $k_i = i$ *māṣas/suvarṇa* $(i = 1, 2, 3, 4)$.
Solution: $K = \frac{1\cdot 1+2\cdot 2+3\cdot 3+4\cdot 4}{1+2+3+4} = \frac{30}{10} = 3$ *māṣas/suvarṇa*.
Verification: based on the equation:

$$Kw_1 + Kw_2 + \cdots + Kw_n = k_1w_1 + k_2w_2 + \cdots + k_nw_n,$$

where each Kw_i is calculated by means of the *trairāśika* (Sūtra C10),

$$Kw_i = T(w_1 + w_2 + \cdots + w_n, k_1w_1 + k_2w_2 + \cdots + k_nw_n, w_i).$$

$Kw_1 = T(10,30,1) = 3$ *māṣas*, $Kw_2 = T(10,30,2) = 6$ *māṣas*, $Kw_3 = T(10,30,3) = 9$ *māṣas*, $Kw_4 = T(10,30,4) = 12$ *māṣas*; and $Kw_1+Kw_2+Kw_3+Kw_4 = 3+6+9+12 = 30$ *māṣas*.

Example 2 for Sūtra 27 (III 33–34): a simple mixture.

Given: $w_i = i$ *suvarṇas*, $k_i = \frac{1}{i+1}$ *māṣa/suvarṇa* ($i = 1,2,3,4$).

Solution: $K = \left(1\cdot\frac{1}{2} + 2\cdot\frac{1}{3} + 3\cdot\frac{1}{4} + 4\cdot\frac{1}{5}\right)/(1+2+3+4) = \left(\frac{163}{60}\right)/10 = \frac{163}{600}$ *māṣa/suvarṇa*.

Verification (cf. the verification of Ex. 1): $Kw_1 = T\left(10, \frac{163}{60}, 1\right) = \frac{163}{600}$ *māṣas*, $Kw_2 = T\left(10, \frac{163}{60}, 2\right) = \frac{163}{300}$ *māṣas*, $Kw_3 = T\left(10, \frac{163}{60}, 3\right) = \frac{163}{200}$ *māṣas*, $Kw_4 = T\left(10, \frac{163}{60}, 4\right) = \frac{163}{150}$ *māṣas*; and $Kw_1 + Kw_2 + Kw_3 + Kw_4 = \frac{163}{60}$ *māṣas*.

Example 3 for Sūtra 27 (III 34): a simple mixture.

Given: $w_i = i$ *suvarṇas*, $k_i = (i+1)$ *māṣas/suvarṇa* ($i = 1,2,3,4,5,6,7,8,9$).

Solution: $K = \frac{1\cdot 2+2\cdot 3+\cdots+9\cdot 10}{1+2+\cdots+9} = \frac{330}{45} = \frac{22}{3}$ *māṣas/suvarṇa*.

Verification (cf. the verification of Ex. 1): $Kw_i = T(45, 330, i) = \frac{330\,i}{45} = \frac{22\,i}{3}$. $Kw_1 + Kw_2 + \cdots + Kw_9 = 330$ *māṣas*.

Remark. For similar examples, see PG Exs. 61 and 62, Tr Exs. 63 and 64, GSS miśraka 170–$171\frac{1}{2}$, and L 104.

Example 1 for Sūtra 28 (III 35–36): a simple mixture.

Given: $w_i = i$ *suvarṇas* ($i = 1,2,3$), $W = 6$ *suvarṇas*. $k_1 = 2, k_2 = 5, K = 4$ *māṣas/suvarṇa*.

Solution: $k_3 = \frac{4\cdot 6-(1\cdot 2+2\cdot 5)}{3} = \frac{24-12}{3} = 4$ *māṣas/suvarṇa*.

Remark. For similar examples, see PG Ex. 65, GSS miśraka 178 and 179, and L 107.

Example 1 for Sūtra 29 (III 36): deterioration.

Given: $w_i = i$ *suvarṇas*, $k_i = i$ *māṣas/suvarṇa* ($i = 1,2,3,4$), $K = 11$ *māṣas/suvarṇa*.

Solution (lost): $W = \frac{16(1+2+3+4)-(1\cdot 1+2\cdot 2+3\cdot 3+4\cdot 4)}{16-11} = \frac{160-30}{5} = 26$ *suvarṇas*.

Remark. Cf. PG Ex. 64, Tr Ex. 66, and L 105, which give examples of refinement.

Sūtras 30–49

Missing (unidentified)

Sūtra 50 (VIII 2)

An indeterminate system of equations of the second degree

Type of problem:

$$\sqrt{x+a} = u, \ \sqrt{x-b} = v,$$

where u and v are rational numbers.

Rule:

$$x = \left(\frac{\frac{a+b}{2} - 2}{2}\right)^2 + b$$

Remarks:
The stanza has been restored from the 'Computation' of Ex. 1.
BSS 18.73 gives the general solution:

$$x = \left(\frac{\frac{a+b}{p} - p}{2}\right)^2 + b.$$

GSS miśraka $275\frac{1}{2}$ solves the same problem thus:

$$x = \frac{\left\{\frac{(a+b)(e+1)}{2}\right\}^2 - e}{4} + 1 \pm \frac{|a-b| \mp e}{2},$$

where,

$$e = \begin{cases} 1 & \text{if } (a+b) \text{ is odd,} \\ 0 & \text{if } (a+b) \text{ is even.} \end{cases}$$

GSS miśraka $279\frac{1}{2}$ treats the special case where $a = b$, and gives the solution:

$$x = \left(\frac{a}{2}\right)^2 + 1.$$

Example 1 (VIII 2).
Given: $a = 5, b = 7$.
Solution: $x = \left(\frac{\frac{5+7}{2} - 2}{2}\right)^2 + 7 = 11$.
Verification: $11 + 5 = 4^2$, and $11 - 7 = 2^2$.
Remark. For similar examples, see BSS 18.84 ($a = 93, b = 67$), and GSS miśraka $276\frac{1}{2}$ ($a = 10, b = 17$), $278\frac{1}{2}$ $\left(a = \frac{3}{7}, b = \frac{2}{3}\right)$, and $280\frac{1}{2}$ ($a = b = 10$).

Sūtra 51 (VIII 2–3)
Linear equation

Type of problem:
One person possesses a cows and b money, and another c cows and d money. Their properties in cash value are equal to each other. What is the price of a cow?

$$ax + b = cx + d$$

Rule:

$$x = \frac{d-b}{a-c}$$

Remarks:
The extant portion of the *sūtra* tells us to obtain the differences, $(a - c)$ and $(d - b)$. The next step will naturally be the division of the latter by the former.

AB 2.30 gives the same formula, using *gulikās* ('beads') instead of 'cows.' Problems of the same type are solved by means of *ekavarṇasamīkaraṇa* ('equations with one unknown') in BSS 18.43, SS 14.14, and BG 89.

Example 1 (VIII 3).
Given: a and b lost; $c = 10, d = 8$ *rūpakas.*
Solution: not given. The text only refers to the nineteenth leaf, which is lost.
Remark. For similar examples, see Exs. 1–5 given by Bhāskara for AB 2.30, and BG 90 and 91.

Sūtra 52 (VIII 3–4)
Consumption of income and stock

Type of problem:
A person earns a and spends b every day. He has the stock c. When does he consume his earnings and stock?

$$f(t) = at + c$$
$$g(t) = bt$$
$$f(t) = g(t)$$

Rule:

$$t = \frac{c}{b - a}$$

Remark:
This formula is equivalent to that of Sūtra C9, and the type of problem is the same in both.

Example 1 (VIII 3–4).
Given: $a = \frac{5}{2}$ *dīnāras*/day, $b = \frac{9}{3} = 3$ *dīnāras*/day, $c = 30$ *dīnāras.*
Solution: $t = 30/\left(3 - \frac{5}{2}\right) = 60$ days.
Verification: *trairāśika* (Sūtra C10). $f(60) = T(2, 5, 60) + 30 = 150 + 30 = 180$ *dīnāras.* $g(60) = T(3, 9, 60) = 180$ *dīnāras.*

Sūtra 53 (VIII 4–6)
Earnings and donation

Type of problem:
A person earns a_1 every t_1 days. Another earns a_2 every t_2 days. Some time after the start of their jobs, the first person gives c to the second, and their properties become equal to each other. What is that time-period (t)?

$$f(t) = \frac{a_1}{t_1}t - c$$
$$g(t) = \frac{a_2}{t_2}t + c$$
$$f(t) = g(t)$$

Rule:

$$t = \frac{2\,c}{\frac{a_1}{t_1} - \frac{a_2}{t_2}}$$

Remark:
Probably the same formula is given also in Sūtra C2.

Exmaple 1 (VIII 4–5).

Given: $a_1 = 5$ *rūpakas*, $t_1 = 3$ days, $a_2 = 6$ *rūpakas*, $t_2 = 5$ days, $c = 7$ *rūpakas*.

Solution: $t = (2 \cdot 7)/\left(\frac{5}{3} - \frac{6}{5}\right) = 14/\left(\frac{7}{15}\right) = 30$ days.

Verification: *trairāśika* (Sūtra C10). $f(30) = T(3,5,30) - 7 = 50 - 7 = 43$ *rūpakas*. $g(30) = T(5,6,30) + 7 = 36 + 7 = 43$ *rūpakas*.

Example 2 (VIII 5–6).

Given: $a_1 = \frac{13}{6}$ *dīnāras*, $t_1 = 1$ day, $a_2 = \frac{3}{2}$ *dīnāras*, $t_2 = 1$ day, $c = 10$ *dīnāras*.

Solution: $t = (2 \cdot 10)/\left(\frac{13}{6} - \frac{3}{2}\right) = 20/\left(\frac{4}{6}\right) = 30$ days.

Verification: *trairāśika* (Sūtra C10). $f(30) = T\left(1, \frac{13}{6}, 30\right) - 10 = 65 - 10 = 55$ *dīnāras*. $g(30) = T\left(1, \frac{3}{2}, 30\right) + 10 = 45 + 10 = 55$ *dīnāras*.

Sūtras 54, 55, 56, and 57 (VIII 6–10)
Buying and selling

Type of problem:
The capital (N) is invested for buying a certain thing at the rate of quantity a per monetary unit, and the purchased thing is sold at the rate of quantity b per monetary unit. Through this commercial transaction is obtained the net profit (or loss) (L), when the total proceeds are M.

$$aN = bM, \quad M = N + L$$

Rule:

Sūtra 54:

$$N = \frac{L}{\frac{a}{b} - 1}$$

Sūtra 55:

$$L = N\left(\frac{a}{b} - 1\right)$$

Sūtra 56:

$$N = \frac{M}{\frac{a}{b}}, \quad L = M - N$$

Sūtra 57:

$$N = \frac{-L}{1 - \frac{a}{b}} \quad (L < 0)$$

Remark:
GSS miśraka 167 gives a formula equivalent to Sūtra 54.

Example 1 for Sūtra 54 (VIII 6–7).
Given: $a = \frac{7}{2}$ per *paṇa*, $b = \frac{6}{3} = 2$ per *paṇa*, $L = 18$ *paṇas*.
Solution: $N = 18/\left\{\left(\frac{7}{2}\right)/2 - 1\right\} = 18/\left(\frac{3}{4}\right) = 24$ *paṇas*.
Verification: *trairāśika* (Sūtra C10). $aN = T(2,7,24) = 84$. $M = T(6,3,84) = 42$ *paṇas*. $L = M - N = 42 - 24 = 18$ *paṇas*.
Remark. For a similar example, see GSS miśraka 168.

Example 1 for Sūtra 55 (VIII 7–8).
Given: $a = \frac{7}{2}$ per *paṇa*, $b = \frac{6}{3} = 2$ per *paṇa*, $N = 24$ *paṇas*.
Solution: $L = 24 \cdot \left\{\left(\frac{7}{2}\right)/2 - 1\right\} = 24 \cdot \frac{3}{4} = 18$ *paṇas*.
Verification: exactly the same as in Ex. 1 for Sūtra 54 above.

Example 1 for Sūtra 56 (VIII 8–9).
Given: $a = \frac{8}{3}, b = \frac{6}{4} = \frac{3}{2}, M = 160$.
Solution: $N = 160/\left\{\left(\frac{8}{3}\right)/\left(\frac{6}{4}\right)\right\} = 160/\left(\frac{32}{18}\right) = 90$. $L = 160 - 90 = 70$.
Verification: *trairāśika* (Sūtra C10). $aN = T(3,8,90) = 240$. $M = T(6,4,240) = 160$. $L = 160 - 90 = 70$.

Example 1 for Sūtra 57 (VIII 9–10).
Given: $a = \frac{16}{5}$ per *rūpaka*, $b = 6$ per *rūpaka*, $L = -56$ *rūpakas*.
Solution: $N = 56/\left\{1 - \left(\frac{16}{5}\right)/6\right\} = 56/\left(\frac{14}{30}\right) = 120$ *rūpakas*.
Verification: *trairāśika* (Sūtra C10). $aN = T(5,16,120) = 384$. $M = T(6,1,384) = 64$ *rūpakas*. $L = M - N = 64 - 120 = -56$.

Sūtra 58 (VIII 10)
Sales tax on clothes

Type of problem:
On the purchase of n garments (*vastra*), whose unit price is a, m of the same garments plus a cash value b are taken away for a sales tax (*śulka*), the rate of which is one p-th of the value.

$$\frac{na}{p} = ma + b$$

Rule:

$$b = T\left(1, a, \frac{n}{p} - m\right) = a\left(\frac{n}{p} - m\right)$$

Remark:
In the only extant example, the unit price (a) is required, and the other quantities are all given.

Example 1 (VIII 10).
Given: $p = 20, n = 42, m = 2, b = 10$ *paṇas*.

Solution (lost): $a = b/\left(\frac{n}{p} - m\right) = 10/\left(\frac{42}{20} - 2\right) = 100$ *paṇas*.

Remark. The rate of the tax, $\frac{1}{20}$, is prescribed in Kauṭilya's *Arthaśāstra* 2.22.7, *Manusmṛti* 8.398, and *Yājñavalkyasmṛti* 2.261.

CHAPTER 2

Unidentified Sūtras

This chapter contains the *sūtras* whose serial numbers have not been identified. They are Sūtras N1–N19.

Sūtra N1 (I 1–4, and V 1 (i))
Proportional distribution

Type of problem:
When a given amount, p, is divided into n parts in the ratio, $m_1 : m_2 : \cdots : m_n$, how much is the share (x_i) of each?

Rule:

$$x_i = m_i q,$$

where

$$q = \frac{p}{m_1 + m_2 + \cdots + m_n}.$$

Remarks:
The *sūtra* itself is lost, and no citation from it is found in the extant examples, if the phrase, *prakṣepayuktyā*, which means either 'by means of the principle of shares' or 'by the sum of the shares,' is not a portion of the *sūtra*. Cf. Sūtra N7, where the same phrase occurs.

The above rule has been restored on the basis of the extant examples.

The same rule is given in BSS 12.16ab, PG 59ab = Tr 38ab, GSS miśraka $79\frac{1}{2}$, SS 13.19ab, MS 15.36, L 94, and PM A33cd.

Example 1 (I 1).
Given: $p = 6$ *palas*, $m_1 : m_2 : m_3 = 16 : 15 : 17$.
Solution: $q = \frac{6}{16+15+17} = \frac{1}{8}$. $x_1 = 16 \cdot \frac{1}{8} = \underline{2\ palas + 0\ tola}$, $x_2 = 15 \cdot \frac{1}{8} = 1$ *pala* + $\underline{7}$ *tolas*, and $x_3 = 17 \cdot \frac{1}{8} = \underline{2\ palas + 1\ tola}$.
Verification: $\underline{x_1 + x_2 + x_3 = 6\ palas}$.
Remark. The above is a tentative restoration, only the underlined portions being extant.

Example 2 (I 1): division of three pieces of meat.
Given: $p = 13$, $m_1 : m_2 : m_3 = \frac{1}{2} : \frac{1}{3} : \frac{1}{4}$.

Solution (lost): $q = 13/\left(\frac{1}{2}+\frac{1}{3}+\frac{1}{4}\right) = 12$. $x_1 = 12\cdot\frac{1}{2} = 6$, $x_2 = 12\cdot\frac{1}{3} = 4$, and $x_3 = 12\cdot\frac{1}{4} = 3$.

Verification (lost): $x_1 + x_2 + x_3 = 13$.

Example 3 (I 2).

Remark. The only information available to us is: $p = 8$ *palas*.

Example 4 (I 2).

Given: $p = 65$ *dīnāras*, $m_1 : m_2 : m_3 = \frac{1}{2} : \frac{1}{3} : \frac{1}{4}$.

Solution: $q = 65/\left(\frac{1}{2}+\frac{1}{3}+\frac{1}{4}\right) = 60$. $x_1 = T(2,1,60) = 30$ *dīnāras*, $x_2 = T(3,1,60) = 20$ *dīnāras*, $x_3 = T(4,1,60) = 15$ *dīnāras*.

Verification: $x_1 + x_2 + x_3 = 65$ *dīnāras*.

Remark. See under Sūtra C10 below for the notation $T(a,b,c)$ of the *trairāśika*.

Example 5 (I 3): exchange of three kinds of unhusked rice (*taṇḍula*) for rice (*vrīhaka*).

Given: $p = 214$, $m_1 : m_2 : m_3 = \frac{2}{5} : \frac{2}{6} : \frac{2}{7}$.

Solution: $q = 214/\left(\frac{2}{5}+\frac{2}{6}+\frac{2}{7}\right) = 214/\left(\frac{214}{210}\right) = 210$.

Verification: *trairāśika* (Sūtra C10). $x_1 = T(5,2,210) = 84$, $x_2 = T(6,2,210) = 70$, and $x_3 = T(7,2,210) = 60$. $x_1 + x_2 + x_3 = 214$.

Remark. The mathematical purport of the problem may be restored thus.

> Three kinds of unhusked rice are exchanged for a single kind of rice in the ratios, 2:5, 2:6, and 2:7 respectively. When two hundred and fourteen units of unhusked rice are given away in total, if an equal amount of rice is obtained for each kind, what is that amount of rice?

Example 6 (I 4).

Remark. The only information available to us is: $p = 105$.

Example 7 (I 4): division of a property by three persons.

Given: $p = 130$, $m_1 : m_2 : m_3 = 1 : 3 : 9$.

Solution: $q = \frac{130}{1+3+9} = 10$. $x_1 = 1\cdot 10 = 10$, $x_2 = 3\cdot 10 = 30$, and $x_3 = 9\cdot 10 = 90$.

Verification: $x_1 + x_2 + x_3 = 130$.

Example 8 (I 4): division of a property by three persons.

Given: $p = 190$, $m_1 : m_2 : m_3 = 4 : 6 : 9$.

Solution: $q = \frac{190}{4+6+9} = 10$. $x_1 = 4\cdot 10 = 40$, $x_2 = 6\cdot 10 = 60$, and $x_3 = 9\cdot 10 = 90$.

Verification: $x_1 + x_2 + x_3 = 190$.

Example 9 (V 1 (i)).

Given: $p = 60$, $m_1 : m_2 : m_3 = 7 : 9 : 14$.

Solution: $q = \frac{60}{7+9+14} = 2$. $x_1 = 7\cdot 2 = 14$, $x_2 = 9\cdot 2 = 18$, and $x_3 = 14\cdot 2 = 28$.

Verification: $x_1 + x_2 + x_3 = 60$.

Remark. For similar examples, see PG Exs. 71–72, GSS miśraka $80\frac{1}{2}$–$86\frac{1}{2}$, L 95, and PM A34.

Sūtra N2 (I 8)
A bill of exchange (*huṇḍikā*)

Remarks:
This *sūtra* has not been understood as yet. For different kinds of *huṇḍikā* and their forms, see Kṣemendra's *Lokaprakāśa*, pp. 13–19 (cf. Weber 1898, 333–345). The *huṇḍikā* is also referred to in the *Rājataraṅgiṇī* (5.266, 275, and 302) of the Kashmirian writer, Kalhaṇa, of the twelfth century (cf. Sarma 1986, 158). See also PG 48–51, which deals with three kinds of problems concerning debts.

Example 1 (I 8).
Remark. Too mutilated to be restored.

Sūtra N3 (I 10–11)
Purchase in proportion

Type of problem:
There are n kinds of commodities; the quantity, a_i, of the i-th commodity costs b_i. When they are purchased in a given proportion, $m_1 : m_2 : \cdots : m_n$, for a certain amount of money, p, how much (x_i) of each commodity is obtained? (Let y_i be the price of the quantity x_i.)

$$x_1 : x_2 : \cdots : x_n = m_1 : m_2 : \cdots : m_n$$
$$\frac{y_i}{x_i} = \frac{b_i}{a_i}$$
$$y_1 + y_2 + \cdots + y_n = p$$

Rule:
$$x_i = \frac{pm_i}{\frac{b_1 m_1}{a_1} + \frac{b_2 m_2}{a_2} + \cdots + \frac{b_n m_n}{a_n}}$$

Remarks:
The formula has been restored from the extant example. The *sūtra* itself is lost, but the stanza,

> *⟨□□□□□□□□□□□⟩ □cchedasaṃguṇe,*
> *(a)⟨□□□□□□□□⟩ ūrdhayutaṃ hṛte phalaṃ.*
>
> ... multiplied by the divisor (or denominator), ... increased by the upper ⟨term⟩, is the result of the division.

which is cited in Example 1, may belong to the present *sūtra* as is indicated in my translation. But it is also possible that that stanza is meant only for the reduction of fractions such as is prescribed in Sūtra Q1.

The same formula is given in PG 95cd = Tr 38cd, GSS miśraka $87\frac{1}{2}$–$89\frac{1}{2}$ (three equivalent rules), MS 15.37–38ab, SS 13.19cd, and L 98.

Example 1 (I 10–11): unhusked rice and kidney beans.

Given: $a_1 = 4\frac{1}{2}$ *ḍhe*, $b_1 = 1$ *dramma* for unhusked rice (*taṇḍula*); $a_2 = 6\frac{1}{2}$ *ḍhe*, $b_2 = 1$ *dramma* for kidney beans (*mudga*); $p = 1$ *dramma*, $m_1 : m_2 = 2 : 1$.

Solution: $x_1 = (1 \cdot 2)/\left\{(1 \cdot 2)/\left(4\frac{1}{2}\right) + (1 \cdot 1)/\left(6\frac{1}{2}\right)\right\} = 2/\left\{2/\left(\frac{9}{2}\right) + 1/\left(\frac{13}{2}\right)\right\} = 2/\left(2 \cdot \frac{2}{9} + 1 \cdot \frac{2}{13}\right) = 2/\left(\frac{4}{9} + \frac{2}{13}\right) = 2/\left(\frac{70}{117}\right) = \frac{234}{70} = 3\frac{24}{70}$ *ḍhe*.

$x_2 = (1 \cdot 1)/\left\{(1 \cdot 1)/\left(4\frac{1}{2}\right) + (1 \cdot 1)/\left(6\frac{1}{2}\right)\right\} = 1/\left(\frac{70}{117}\right) = \frac{117}{70} = 1\frac{47}{70}$ *ḍhe*.

Remarks. The abbreviation, *ḍhe*, for a certain measure has not been identified.

The fragment, $70^r F^2$ (I 1), in which occurs the fraction, $\frac{117}{70}$, seems to be a portion of this example, but its proper place is uncertain.

For similar examples, see PG Ex. 73–74 (*taṇḍula* and *mudga*) = Tr Ex. 71–72, PG Ex. 75 (*hiṅgu* and *śuṇṭhī*) = Tr Ex. 70, GSS miśraka $90\frac{1}{2}$–$91\frac{1}{2}$ (*dāḍima*, *āmra*, and *kapittha*), and L 99 (*taṇḍula* and *mudga*).

Sūtra N4 (I 15–16)

Purchase of the same number of articles

Type of problem:

There are n kinds of commodities; the quantity (a_i) of the i-th commodity is obtained for one monetary unit ($i = 1, 2, \cdots, n$). In order to buy the same number (y) of articles of every kind, how much money (x_i) is required for each kind?

$$a_i x_i = y$$

for every i $(i = 1, 2, \cdots, n)$.

Rule:

$$x_i = b_i,$$

where the set of b_i $(i = 1, 2, \cdots, n)$ satisfies the condition:

$$\frac{1}{a_i} = \frac{b_i}{A}$$

for a certain A.

Remarks:

If the least common multiple of a_i is taken to be A, then the b_i's are the least positive solutions. The relation, $y = A$, may also have been mentioned in the present *sūtra*.

The same type of problem is treated in PM A15, which takes y to be the product of all a_i's.

Example 1 (I 15–16).

Given: $a_1 = 1, a_2 = 2, a_3 = 3, a_4 = 4, a_5 = 6$ per *dramma*.

Solution: $x_1 = 12, x_2 = 6, x_3 = 4, x_4 = 3, x_5 = 2$ *drammas*. ($y = A = 12$.)

Verification: *trairāśika* (Sūtra C10). $a_1x_1 = T(1,1,12) = 12 = y$, $a_2x_2 = T(1,2,6) = 12 = y$, $a_3x_3 = T(1,3,4) = 12 = y$, $a_4x_4 = T(1,4,3) = 12 = y$, $a_5x_5 = T(1,6,2) = 12 = y$.

Remark. For similar examples, see PM A16 and B14, the latter of which takes y to be the least common multiple of the a_i's.

Sūtra N5 (I 17)
Equation of journeys

Type of problem: Same as that of Sūtra 15.

Rule:

$$t_2 = \frac{v_2 - v_1}{v_1 t_1}$$

Remark:
The stanza (see Appendix A), which has been restored from the Computation of *Example 1*, gives the same formula as Sūtra 15.

Example 1 (I 17).
Given: $v_1 = \frac{3}{2}$ *yojanas*/day, $v_2 = 2$ *yojanas*/day, $t_1 = 6$ days.
Solution: $t_2 = \left(\frac{3}{2} \cdot 6\right) / \left(2 - \frac{3}{2}\right) = 9/\left(\frac{1}{2}\right) = 18$ days.
Verification: *trairāśika* (Sūtra C10). The distance traveled by the first man $= \frac{3}{2} \cdot 6 + T\left(1, \frac{3}{2}, 18\right) = 9 + 27 = 36$ *yojanas*. The distance traveled by the second man $= T(1, 2, 18) = 36$ *yojanas*.
Remark. This verification is followed by another *trairāśika*: $T\left(1, 8, \frac{9}{12}\right) = 6$, the purpose of which I do not understand.

Sūtra N6 (II 1–9)
A system of linear equations

Type of problem:
The quantity (p) of a certain thing is divided into n parts in such a way that the i-th part (x_i) can be expressed as $a_i x_0 + b_i$ for every i ($i = 1, 2, \cdots, n$).

$$x_i = a_i x_0 + b_i \quad (i = 1, 2, \cdots, n)$$
$$x_1 + x_2 + \cdots + x_n = p$$

Rule:

$$x_0 = \frac{p - (b_1 + b_2 + \cdots + b_n)}{a_1 + a_2 + \cdots + a_n}$$

Remarks:
The *sūtra* calls p, a_i, and b_i respectively *bhājya* ('to be divided'), *puruṣa* ('the ⟨number of⟩ persons'), and *uttara* ('the remainder' or 'the difference'). On the basis of this terminology, we may restore the type of problem for which the *sūtra* was originally designed.
Original type of problem restored.

> The quantity (p) of a certain thing is divided into n parts. Each part (x_i) is again divided equally among a_i persons with a residue (b_i), and every person obtains the same amount (x_0).

Several problems similar to this original type, though not exactly the same, are treated in GSS miśraka $98\frac{1}{2}$–$101\frac{1}{2}$.

Example 1 (II 1–2).

Given: $x_1 = x_0+2,\ \ x_2 = 2\,x_1-3,\ \ x_3 = 2\,x_2-4,\ \ x_4 = 2\,x_3-5;\ \ x_1+x_2+x_3+x_4 = 82.$

Solution: $x_1 = x_0 + 2,\ \ x_2 = 2\,x_0 + 1,\ \ x_3 = 4\,x_0 - 2,\ \ x_4 = 8\,x_0 - 9;\ \ x_0 = \frac{82-(2+1-2-9)}{1+2+4+8} = \frac{82-(-8)}{15} = \frac{90}{15} = 6.$

Remarks. Note that, in the above solution, the x_i's are first rewritten in the forms to which Sūtra N6 is applicable. The first extant enclosure in (II 1), in which only the coefficients of x_0, 1, 2, 4, and 8, are written, shows a transitional stage from the given forms of x_i's to the rewritten forms.

Example 2 (II 2–3).

Remark. Too mutilated to be restored.

Example 3 (II 4–5): a joint investment by three men.

Given: $x_1 = x_0,\ \ x_2 = 2\cdot\frac{3}{2}x_1 + 2,\ \ x_3 = 2\cdot\frac{3}{2}x_2 - 3.\ \ y_1 = \frac{1}{4}x_1,\ \ y_2 = \frac{1}{2}x_2,\ \ y_3 = \frac{1}{3}x_3.\ \ y_1 + y_2 + y_3 = 21$ *dīnāras*.

Solution: $y_1 = \frac{1}{4}x_0,\ \ y_2 = \frac{3}{2}x_0 + 1,\ \ y_3 = 3\,x_0 + 1.\ \ x_0 = \{21 - (1+1)\} / \left(\frac{1}{4} + \frac{3}{2} + 3\right) = 19/\left(\frac{19}{4}\right) = 4$ *dīnāras*, $x_1 = 4$ *dīnāras*, $x_2 = 2\cdot\frac{3}{2}\cdot 4+2 = 14$ *dīnāras*, $x_3 = 2\cdot\frac{3}{2}\cdot 14-3 = 39$ *dīnāras*.

Verification: *trairāśika* (Sūtra C10). $y_1 = T\left(1, 4, \frac{1}{4}\right) = 1$ *dīnāra*, $y_2 = T\left(1, 14, \frac{1}{2}\right) = 7$ *dīnāras*, $y_3 = T\left(1, 39, \frac{1}{3}\right) = 13$ *dīnāras*. $y_1 + y_2 + y_3 = 21$ *dīnāras*.

Remarks. The purport of the problem may be restored thus.

> Three men buy a certain thing at 21 *dīnāras*. The first man contributes one fourth of his property (x_1), the second man one half of his (x_2), and the third man one third of his (x_3). The property of the second is twice one and a half that of the first, plus two; and that of the third is twice one and a half that of the second, minus three. What is the property of each?

In the solution, the given forms of y_i's are first rewritten in terms of x_0. In that process the property of the first man, $x_0(= x_1)$, is supposed to be *yā* $\frac{1}{1}$, which is the abbreviation of *yāvattāvat* followed by its coefficient, $\frac{1}{1}$. See Sec. 6.6 of the Introduction.

Example 4 (II 6): number of animals in a stable.

Given: $x_1 = \frac{1}{4}x_0 - 3,\ \ x_2 = \frac{1}{6}x_0 - 4,\ \ x_3 = \frac{1}{5}x_0 - 5.\ \ x_1 + x_2 + x_3 = 99.$

Solution: $x_0 = \{99 - (-3-4-5)\} / \left(\frac{1}{4} + \frac{1}{6} + \frac{1}{5}\right) = \{99 - (-12)\} / \left(\frac{37}{60}\right) = 111/\left(\frac{37}{60}\right) = 180.$

Verification: *trairāśika* (Sūtra C10). $x_1 = T\left(1, 180, \frac{1}{4}\right) - 3 = 45 - 3 = 42,\ \ x_2 = T\left(1, 180, \frac{1}{6}\right) - 4 = 30 - 4 = 26,\ \ x_3 = T\left(1, 180, \frac{1}{5}\right) - 5 = 36 - 5 = 31.\ \ x_1 + x_2 + x_3 = 99.$

Remark. The problem may be restored thus.

> There are three stables, the first of which contains a certain number (x_0) of cows, the second the same number of horses, the third also the same number of she-buffaloes. The sum of one fourth of those cows less three, one sixth of those horses less four, and one fifth of those she-buffaloes less five, is one hundred less one. How many animals are there in each stable?

Example 5 (II 6, under leaf).

Remark. Too mutilated to be restored.

Example 6 (II 7): properties of four persons(?)

Given: $x_1 = x_0,\ x_2 = x_0 + 1,\ x_3 = x_0 + 2,\ x_4 = x_0 + 3.\ x_1 + x_2 + x_3 + x_4 = 54.$

Solution: $x_0 = \frac{54-(1+2+3)}{1+1+1+1} = \frac{48}{4} = 12,\ x_1 = 12,\ x_2 = 13,\ x_3 = 14,\ x_4 = 15.\ x_1 + x_2 + x_3 + x_4 = 54.$

Example 7 (II 7): donation by a king to five horsemen.

Given: $x_1 = x_0,\ x_2 = 2\,x_1 + 1,\ x_3 = 2\,x_2 + 1,\ x_4 = 2\,x_3 + 1,\ x_5 = 2\,x_4 + 1.\ x_1 + x_2 + x_3 + x_4 + x_5 = 57.$

Solution: $x_1 = x_0,\ x_2 = 2\,x_0 + 1,\ x_3 = 4\,x_0 + 3,\ x_4 = 8\,x_0 + 7,\ x_5 = 16\,x_0 + 15.\ x_0 = \frac{57-(1+3+7+15)}{1+2+4+8+16} = \frac{31}{31} = 1,\ x_1 = 1,\ x_2 = 3,\ x_3 = 7,\ x_4 = 15,\ x_5 = 31.\ x_1+x_2+x_3+x_4+x_5 = 57.$

Remark. The solution is lost except for the Statement, which gives the coefficients in terms of x_0.

Example 8 (II 8): properties of five men(?)

Given: $x_1 = x_0,\ x_2 = 3\,x_0 + \frac{3}{2},\ x_3 = 9\,x_0 + 6,\ x_4 = 27\,x_0 + \frac{39}{2},\ x_5 = 81\,x_0 + 60.\ x_1 + x_2 + x_3 + x_4 + x_5 = 329.$

Solution: $x_0 = \left\{329 - \left(\frac{3}{2} + 6 + \frac{39}{2} + 60\right)\right\}/(1 + 3 + 9 + 27 + 81) = \frac{242}{121} = 2.\ x_1 = 2,\ x_2 = \frac{2}{15},\ x_3 = 24,\ x_4 = \frac{147}{2},\ x_5 = 222.\ x_1 + x_2 + x_3 + x_4 + x_5 = 329.$

Remark. The Statement gives the coefficients in terms of x_0, but their original forms given in the problem, which is lost, may well have been thus (cf. Example 7 above): $x_1 = x_0,\ x_2 = 3\,x_1 + \frac{3}{2},\ x_3 = 3\,x_2 + \frac{3}{2},\ x_4 = 3\,x_3 + \frac{3}{2},\ x_5 = 3\,x_4 + \frac{3}{2}.$

Example 9 (II 9): number of horses in a troop (? *vaṃsura*).

Given: $x_1 = \frac{1}{10}x_0,\ x_2 = \frac{1}{8}x_0,\ x_3 = \frac{1}{4}x_0;\ x_1 + x_2 + x_3 = 57.$

Solution: $x_0 = 57/\left(\frac{1}{10} + \frac{1}{8} + \frac{1}{4}\right) = 57/\left(\frac{19}{40}\right) = 57 \cdot \frac{40}{19} = 3 \cdot 40 = 120.$

Verification: *trairāśika* (Sūtra C10). $x_1 = T\left(1, 120, \frac{1}{10}\right) = 12,\ x_2 = T\left(1, 120, \frac{1}{8}\right) = 15,\ x_3 = T\left(1, 120, \frac{1}{4}\right) = 30.\ x_1 + x_2 + x_3 = 57.$

Remark. The purport of the problem may be restored thus.

> There are three troops of horses, each of which contains the same numner (x_0) of horses. When another troop is made by taking one tenth of the first troop, one eighth of the second, and one fourth of the third, the number of horses in it is known to be fifty-seven. How many horses are there in each of the original troops?

Sūtra N7 (IV 1–3)

Installments

Type of problem:

There are n persons, to whom the total sum of p is given in the time-period t. The installment per time-period t_i for the i-th person is a_i.

$$\frac{a_1}{t_1} \cdot t + \frac{a_2}{t_2} \cdot t + \cdots + \frac{a_n}{t_n} \cdot t = p$$

Rule:

$$t = \frac{p}{\frac{a_1}{t_1} + \frac{a_2}{t_2} + \cdots + \frac{a_n}{t_n}}$$
$$A_i = \frac{a_i}{t_i} \cdot t,$$

where A_i is the sum obtained by the i-th person.

Remark:
Probably, the phrase, *prakṣepayuktyā* ('by the sum of the shares'), belongs to this *sūtra* also. Cf. Sūtra N1 above.

Example 1 (IV 1): donation to three poets (? cf. the word, *kavaye*, on fragment $21^r F^1$).

Given: $a_1 = a_2 = 1$ *rūpa*, $a_3 = 3$ *rūpas*. $t_1 = \frac{1}{3}$ day, $t_2 = \frac{1}{2}$ day, $t_3 = 5$ days. $p = 100$ *rūpas*.

Solution: $t = 100/\left\{1/\left(\frac{1}{3}\right) + 1/\left(\frac{1}{2}\right) + \frac{3}{5}\right\} = \frac{125}{7}$ days. $A_1 = \frac{375}{7}$ *rūpas*, $A_2 = \frac{250}{7}$ *rūpas*, $A_3 = \frac{75}{7}$ *rūpas*.

Example 2 (IV 2–3): means of livelihood of three men.

Given: $a_i = (i+1) + \frac{1}{2}$ *dīnāras*. $t_i = 1 + \frac{1}{i+1}$ days ($i = 1, 2, 3$). $p = 500$ *dīnāras*.

Solution: $t = 500/\left\{\left(\frac{5}{2}\right)/\left(\frac{3}{2}\right) + \left(\frac{7}{2}\right)/\left(\frac{4}{3}\right) + \left(\frac{9}{2}\right)/\left(\frac{5}{4}\right)\right\} = 500/\left(\frac{10}{6} + \frac{21}{8} + \frac{36}{10}\right) = \frac{60000}{947}$ *dīnāras*. $A_1 = \frac{100000}{947}$ *dīnāras*, $A_2 = \frac{157500}{947}$ *dīnāras*, $A_3 = \frac{216000}{947}$ *dīnāras*. $A_1 + A_2 + A_3 = \frac{473500}{947} = 500$ *dīnāras*.

Verification: *trairāśika* (Sūtra C10). $t = T(a_1, t_1, A_1) = T\left(\frac{5}{2}, \frac{3}{2}, \frac{100000}{947}\right) = \frac{60000}{947}$ days. $t = T(a_2, t_2, A_2) = T\left(\frac{7}{2}, \frac{4}{3}, \frac{157500}{947}\right) = \frac{60000}{947}$ days. $t = T(a_3, t_3, A_3) = T\left(\frac{9}{2}, \frac{5}{4}, \frac{216000}{947}\right) = \frac{60000}{947}$ days.

Sūtras N8–N12 (IV 4–11)

Iṣṭakarman (regula falsi) for three kinds of problems

Type of problem:
Six systems of linear equations are treated in this section.

Type	Equations
Aa:	$x_1 = a_1 x_0$
	$x_i = a_i x_1 \quad (i = 2, 3, \cdots, n)$
	$x_1 + x_2 + \cdots + x_n = p$
Ab:	$x_1 = a_1 x_0$
	$x_i = a_i x_{i-1} \quad (i = 2, 3, \cdots, n)$
	$x_1 + x_2 + \cdots + x_n = p$
Ac:	$x_1 = a_1 x_0$
	$x_i = a_i(x_1 + x_2 + \cdots + x_{i-1}) \quad (i = 2, 3, \cdots, n)$
	$x_1 + x_2 + \cdots + x_n = p$

Ba: $x_1 = a_1 x_0 + b_1 x_0$
$x_i = a_i x_1 \pm b_i x_0 \quad (i = 2, 3, \cdots, n)$
$x_1 + x_2 + \cdots + x_n = p$

Bb: $x_1 = a_1 x_0 + b_1 x_0$
$x_i = a_i x_{i-1} \pm b_i x_0 \quad (i = 2, 3, \cdots, n)$
$x_1 + x_2 + \cdots + x_n = p$

Bc: $x_1 = a_1 x_0 + b_1 x_0$
$x_i = a_i(x_1 + x_2 + \cdots + x_{i-1}) \pm b_i x_0 \quad (i = 2, 3, \cdots, n)$
$x_1 + x_2 + \cdots + x_n = p$

Rule:
Let

$$x_1 + x_2 + \cdots + x_n = f(x_0).$$

Suppose $x_0 = t$, and, by calculating exactly as stated in the problem, find the sum $f(t) = q$. Then,

$$x_0 = \frac{p\,t}{q}.$$

Sūtras N8 and N12 take t to be unity, while Sūtras N9–N11 'any opotional number' (*kāmika/yadṛcchā/iṣṭa*). It is, however, always taken to be unity in the extant examples of Sūtras N9–N11 also. Each Sūtra, except N12, pertains to a single type of problem thus:

Sūtra N8:	Type Aa
Sūtra N9:	Type Ab
Sūtra N10:	Type Ac
Sūtra N11:	Type Bb(+)
Sūtra N12:	Types Ba(±), Bb(−), Bc(±)

The symbols, + and −, in Case B indicate respectively the types in which the positive and negative signs occur for the last term $b_i x_0$ of x_i.

Remarks:
These *sūtras* (N8–N12) are only partially preserved, but their purports have been made clear by the extant examples.

The three types of problems, (a), (b), and (c), are referred to by the phrase, *triprakāra* ('three kinds ⟨of problems⟩'). See (IV 11). Types (b) and (c) are specifically termed respecetively *vargakramagaṇita* ('arithmetic of multiplicative series') and *yutivargagaṇita* ('arithmetic of additive-multiplicative ⟨series⟩'). See (IV 5) and (IV 6).

Notably, the text assumes

$$a_i = i, \quad b_i = i + \frac{1}{2} \quad (i = 1, 2, 3, 4)$$

in all of the extant examples, and gives the value of p in such a way that the value of x_0 is always found to be an integer in Case A, and unity in Case B, where the last term of x_i, i.e., $b_i x_0$, is treated as if it were an absolute term, b_i.

GSS kalāsavarṇa 107 applies the *iṣṭakarman* to a certain kind of problem of fractions, and GSS kṣetra $112\frac{1}{2}$ to a certain type of geometric problems. Both take the optional number to be unity. The former stanza reads thus:

rūpaṃ nyasyāvyakte prāgvidhinā yat phalaṃ bhavet tena,
bhaktaṃ paridṛṣṭaphalaṃ prabhāgajātau tad ajñātam //107//

Having placed unity in the place of the unknown quantity, a result will be ⟨obtained⟩ by means of the previous rule. By it is divided the given (lit. observed) result. It (the final result) is the unknown in the class of multi-fractions.

The example given in GSS kalāsavarṇa 108 is this:

$$\frac{x}{8}+\frac{\frac{x}{2}}{4}+\frac{\frac{x}{2}}{5}+\frac{\frac{3\cdot\frac{x}{6}}{4}}{5}=\frac{1}{2}.$$

The younger Bhāskara (L 51) teaches the *iṣṭakarman* with any optional number, without restricting the types of problems.

For the *iṣṭakarman*, see also under Sūtras 25 and 26.

Example 1 for Sūtra N8 (IV 4): Type Aa — donation to four persons.

Given: $x_1 = x_0,\ x_i = i \cdot x_1\ \ (i = 2,3,4);\ \ x_1 + x_2 + x_3 + x_4 = 200\ (= p)$.

Solution: Suppose $x_0 = 1$, then $x_1 = 1,\ x_2 = 2,\ x_3 = 3,\ x_4 = 4;\ \ x_1 + x_2 + x_3 + x_4 = 10\ (= q)$. Hence, $x_0 = \frac{200}{10} = 20$; and $x_1 = 20,\ x_2 = 40,\ x_3 = 60,\ x_4 = 80$. By adding up, we have the sum, 200, which can also be obtained by means of the 'Minus-One' method (Sūtra Q12): $\left\{20 + \frac{(4-1)\cdot 20}{2}\right\} \cdot 4 = 200$.

Example 1 for Sūtra N9 (IV 5): Type Ab — donation by four persons.

Given: $x_i = i \cdot x_{i-1}\ \ (i = 1,2,3,4);\ \ x_1 + x_2 + x_3 + x_4 = 132\ (= p)$.

Solution: Suppose $x_0 = 1$, then $x_1 = 1,\ x_2 = 2,\ x_3 = 6,\ x_4 = 24;\ \ x_1 + x_2 + x_3 + x_4 = 33\ (= q)$. Hence, $x_0 = \frac{132}{33} = 4$; and $x_1 = 4,\ x_2 = 8,\ x_3 = 24,\ x_4 = 96.\ \ x_1 + x_2 + x_3 + x_4 = 132$.

Example 1 for Sūtra N10 (IV 6): Type Ac — properties of four persons.

Given: $x_1 = x_0,\ x_2 = 2x_1,\ x_3 = 3(x_1 + x_2),\ x_4 = 4(x_1 + x_2 + x_3);\ \ x_1 + x_2 + x_3 + x_4 = 300\ (= p)$.

Solution: Suppose $x_0 = 1$, then $x_1 = 1,\ x_2 = 2 \cdot 1 = 2,\ x_3 = 3 \cdot 3 = 9,\ x_4 = 4 \cdot 12 = 48;\ \ x_1 + x_2 + x_3 + x_4 = 60\ (= q)$. Hence, $x_0 = \frac{300}{60} = 5$; and $x_1 = 5,\ x_2 = 10,\ x_3 = 45,\ x_4 = 240.\ \ x_1 + x_2 + x_3 + x_4 = 300$.

Example 2 for Sūtra N10 (IV 6).

Remark. Too mutilated to be restored.

Example 1 for Sūtra N11 (IV 7): Type Bb(+) — donation(?) of four persons.

Given: $x_i = i \cdot x_{i-1} + \left(i + \frac{1}{2}\right) x_0\ \ (i = 1,2,3,4);\ \ x_1 + x_2 + x_3 + x_4 = 144\frac{1}{2}\ (= p)$.

Solution: Suppose $x_0 = 1$, then $x_1 = \frac{5}{2},\ x_2 = \frac{15}{2},\ x_3 = \frac{52}{2},\ x_4 = \frac{217}{2};\ \ x_1 + x_2 + x_3 + x_4 = \frac{289}{2}\ (= q)$. Hence, $x_0 = \left(144\frac{1}{2}\right) / \left(\frac{289}{2}\right) = 1$; and $x_1 = 2\frac{1}{2},\ x_2 = 7\frac{1}{2},\ x_3 = 26,\ x_4 = 108\frac{1}{2}.\ \ x_1 + x_2 + x_3 + x_4 = 144\frac{1}{2}$.

Example 1 for Sūtra N12 (IV 8): Type Bc(+) — donation by four persons.

Given: $x_1 = x_0 + \frac{3}{2}x_0,\ x_2 = 2\,x_1 + \frac{5}{2}x_0,\ x_3 = 3(x_1 + x_2) + \frac{7}{2}x_0,\ x_4 = 4(x_1 + x_2 + x_3) + \frac{9}{2}x_0;\ \ x_1 + x_2 + x_3 + x_4 = 222\ (= p)$.

Solution: Suppose $x_0 = 1$, then $x_1 = \frac{5}{2}$, $x_2 = \frac{15}{2}$, $x_3 = \frac{67}{2}$, $x_4 = \frac{357}{2}$; $x_1+x_2+x_3+x_4 = 222$ $(= q)$. Hence, $x_0 = \frac{222}{222} = 1$; and x_i's remain the same.

Example 2 for Sūtra N12 (IV 8–9): Type Ba(+).

Given: $x_1 = x_0+\frac{3}{2}x_0,\ x_i = i\cdot x_1+\left(i+\frac{1}{2}\right)x_0\ \ (i = 2,3,4);\ \ x_1+x_2+x_3+x_4 = \frac{71}{2}\ (= p)$.

Solution: Suppose $x_0 = 1$, then $x_1 = \frac{5}{2}$, $x_2 = \frac{15}{2}$, $x_3 = \frac{22}{2}$, $x_4 = \frac{29}{2}$; $x_1+x_2+x_3+x_4 = \frac{71}{2}$ $(= q)$. Hence, $x_0 = 1$; and x_i's remain the same.

Example 3 for Sūtra N12 (IV 9): Type Bb(−) — donation by four persons.

Given: $x_1 = x_0+\frac{3}{2}x_0,\ x_i = i\cdot x_{i-1}-\left(i+\frac{1}{2}\right)x_0\ \ (i = 2,3,4);\ \ x_1+x_2+x_3+x_4 = \frac{41}{2}\ (= p)$.

Solution: Suppose $x_0 = 1$, then $x_1 = \frac{5}{2}$, $x_2 = \frac{5}{2}$, $x_3 = \frac{8}{2}$, $x_4 = \frac{23}{2}$; $x_1+x_2+x_3+x_4 = \frac{41}{2}$ $(= q)$. Hence, $x_0 = 1$; and x_i's remain the same.

Remark. The solution, except for the Statement, is lost.

Example 4 for Sūtra N12 (IV 10): Type Bc(−).

Given: $x_1 = x_0+\frac{3}{2}x_0,\ x_2 = 2x_1-\frac{5}{2}x_0,\ x_3 = 3(x_1+x_2)-\frac{7}{2}x_0,\ x_4 = 4(x_1+x_2+x_3)-\frac{9}{2}x_0;\ \ x_1+x_2+x_3+x_4 = 78\ (= p)$.

Solution: Suppose $x_0 = 1$, then $x_1 = \frac{5}{2}$, $x_2 = \frac{5}{2}$, $x_3 = \frac{23}{2}$, $x_4 = \frac{123}{2}$; $x_1+x_2+x_3+x_4 = \frac{156}{2}$ $(= 78 = q)$. Hence, $x_0 = 1$; and x_i's remain the same.

Example 5 for Sūtra N12 (IV 11): Type Ba(−).

Given: $x_1 = x_0+\frac{3}{2}x_0,\ x_i = i\cdot x_1-\left(i+\frac{1}{2}\right)x_0\ \ (i = 2,3,4);\ \ x_1+x_2+x_3+x_4 = \frac{29}{2}\ (= p)$.

Solution: Suppose $x_0 = 1$, then $x_1 = \frac{5}{2}$, $x_2 = \frac{5}{2}$, $x_3 = \frac{8}{2}$, $x_4 = \frac{11}{2}$; $x_1+x_2+x_3+x_4 = \frac{29}{2}$ $(= q)$. Hence, $x_0 = 1$; and x_i's remain the same.

Sūtra N13 (V 2)
Proportional distribution

Type of problem:
There are n kinds of liquids, each of which fills a pot. The capasity of the i-th pot is a_i. Having mixed up all liquids, one divides the mixture into those n pots again. How many units of each liquid are contained in each pot?

$$x_{i1} : x_{i2} : \cdots : x_{in} = a_1 : a_2 : \cdots : a_n$$

$$x_{i1} + x_{i2} + \cdots + x_{in} = a_i$$

Rule:
According to the general rule for proportional distribution (Sūtra N1), the quantity (x_{ij}) of the j-th liquid contained in the i-th pot is obtained by:

$$x_{ij} = \frac{a_i \cdot a_j}{a_1 + a_2 + \cdots + a_n}.$$

Sūtra N13 gives a rule for producing all of these answers (n^2 in number) simultaneously in tabular form.

1. 'Having put down as many ⟨numerals representing each⟩ share as substances':

$$
\begin{array}{cc|ccccc}
 & & & & \text{substance} & & \\
 & & 1 & \cdots & j & \cdots & n \\
\hline
 & 1 & a_1 & \cdots & a_j & \cdots & a_n \\
 & \vdots & \vdots & & \vdots & & \vdots \\
\text{pot} & i & a_1 & \cdots & a_j & \cdots & a_n \\
 & \vdots & \vdots & & \vdots & & \vdots \\
 & n & a_1 & \cdots & a_j & \cdots & a_n
\end{array}
$$

2. 'And placed the sum of the shares ⟨under each term⟩': Each term in the table is divided by the total sum, $S \;\; (= a_1 + a_2 + \cdots + a_n)$.

$$
\begin{array}{cc|ccccc}
 & & & & \text{substance} & & \\
 & & 1 & \cdots & j & \cdots & n \\
\hline
 & 1 & \frac{a_1}{S} & \cdots & \frac{a_j}{S} & \cdots & \frac{a_n}{S} \\
 & \vdots & \vdots & & \vdots & & \vdots \\
\text{pot} & i & \frac{a_1}{S} & \cdots & \frac{a_j}{S} & \cdots & \frac{a_n}{S} \\
 & \vdots & \vdots & & \vdots & & \vdots \\
 & n & \frac{a_1}{S} & \cdots & \frac{a_j}{S} & \cdots & \frac{a_n}{S}
\end{array}
$$

3. 'Multiply separately ⟨the terms in each row⟩ by ⟨each of⟩ the shares': Each term of the i-th row is multiplied by a_i. Thus, the j-th term of the i-th row (x_{ij}) becomes $\frac{a_i a_j}{S}$, which is the quantity of the j-th substance in the i-th pot.

$$
\begin{array}{cc|ccccc}
 & & & & \text{substance} & & \\
 & & 1 & \cdots & j & \cdots & n \\
\hline
 & 1 & \frac{a_1^2}{S} & \cdots & \frac{a_1 a_j}{S} & \cdots & \frac{a_1 a_n}{S} \\
 & \vdots & \vdots & & \vdots & & \vdots \\
\text{pot} & i & \frac{a_1 a_i}{S} & \cdots & \frac{a_i a_j}{S} & \cdots & \frac{a_i a_n}{S} \\
 & \vdots & \vdots & & \vdots & & \vdots \\
 & n & \frac{a_1 a_n}{S} & \cdots & \frac{a_j a_n}{S} & \cdots & \frac{a_n^2}{S}
\end{array}
$$

Example 1 (V 2): mixture of honey, water, and milk.

Given: $a_1 = 4$ (honey), $a_2 = 5$ (water), $a_3 = 6$ (milk).

Solution: H = honey, W = water, and M = milk.

1st step			2nd step			3rd step			
4	5	6	$\frac{4}{15}$	$\frac{5}{15}$	$\frac{6}{15}$	$\frac{16}{15}$	$\frac{20}{15}$	$\frac{24}{15}$	1st pot
4	5	6	$\frac{4}{15}$	$\frac{5}{15}$	$\frac{6}{15}$	$\frac{20}{15}$	$\frac{25}{15}$	$\frac{30}{15}$	2nd pot
4	5	6	$\frac{4}{15}$	$\frac{5}{15}$	$\frac{6}{15}$	$\frac{24}{15}$	$\frac{30}{15}$	$\frac{36}{15}$	3rd pot
						H	W	M	

Verification: Quantity of honey $= \frac{16}{15} + \frac{20}{15} + \frac{24}{15} = 4$. Quantity of water $= \frac{20}{15} + \frac{25}{15} + \frac{30}{15} = 5$. Quantity of milk $= \frac{24}{15} + \frac{30}{15} + \frac{36}{15} = 6$.

Remark. An example of the same type (mixture of curds, ghee, and milk) occurs in GSS miśraka $92\frac{1}{2}$–$94\frac{1}{2}$, but it is given under the rules for purchase in proportion, GSS miśraka $87\frac{1}{2}$–$89\frac{1}{2}$. Cf. Sūtra N3 above.

Sūtra N14 (V 5–6)
Volume of an irregular solid

Type of problem:
The solid here treated is called *vāhasya kāṇḍa* in Example 1. What is meant by this expression is not clear to me, but it seems to be either the trunk of an elephant or the torso of any kind of a draught animal (*vāha*). See Figure 2.1a.

Rule:
Let V be the volume of the irregular solid of Figure 2.1a. Then,

$$V = abc,$$

where

$$a = \frac{a_1 + a_2}{2} \quad (2.1)$$

$$b = \frac{b_1 + b_2 + \cdots + b_n}{n} \quad (2.2)$$

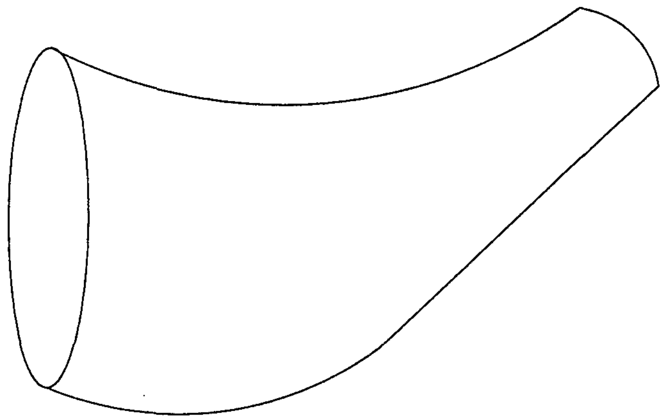
$$c = \frac{c_1 + c_2 + \cdots + c_m}{m} \quad (2.3)$$

The lengths, a_1 and a_2, are measured along the curves of the back (*pṛṣṭha*) and the belly (*udara*) of the solid figure (Figure 2.1b). The lengths, b_i and c_i, are measured along the straight lines supposed respectively in a vertical section (Figure 2.1b) and a horizontal section (Figure 2.1c).

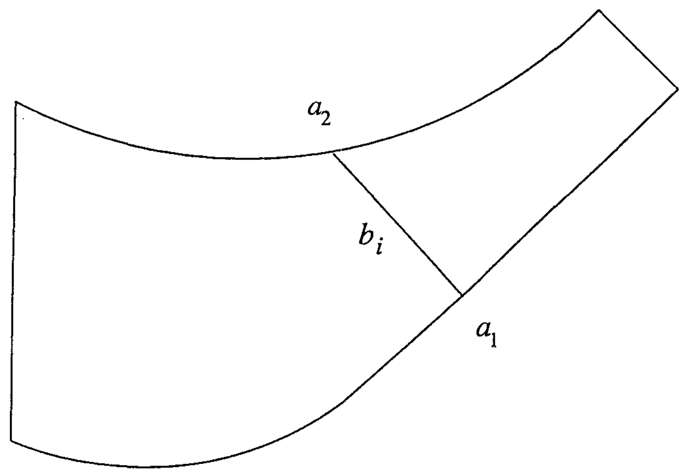
Remarks:
The idea of the mean length expressed in (2.1) is found in the elder Bhāskara's commentary on AB 2.8 (p. 70), where he calculates the area of an 'ivory-like' plane figure (*karidantakṣetra*, Figure 2.2) by using the formula:

$$S = \frac{a_1 + a_2}{2} \cdot \frac{b}{2}.$$

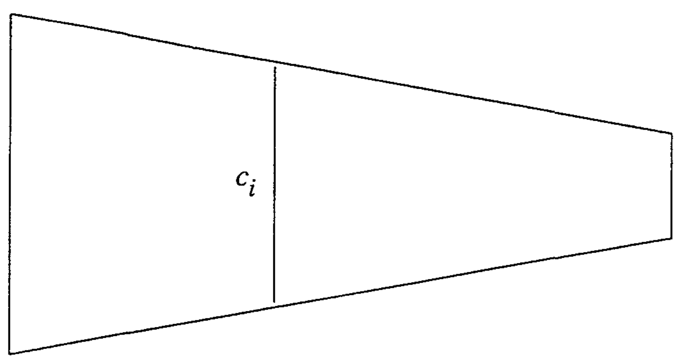
On the other hand, the idea of the mean length expressed in (2.2) and (2.3) was used for obtaining the content of a rectangular ditch with irregular sides (*viṣamakhāta*) by most Indian mathematicians since the time of Brahmagupta (Figure 2.3). See BSS 12.44cd, Tr 52, GSS khāta 4cd and 9–10, MS 15.105ab, SS 13.43ab, and L 214.



a. The Irregular Solid



b. Vertical Section



c. Horizontal Section

Figure 2.1: The Irregular Solid Called *vāhakāṇḍa*

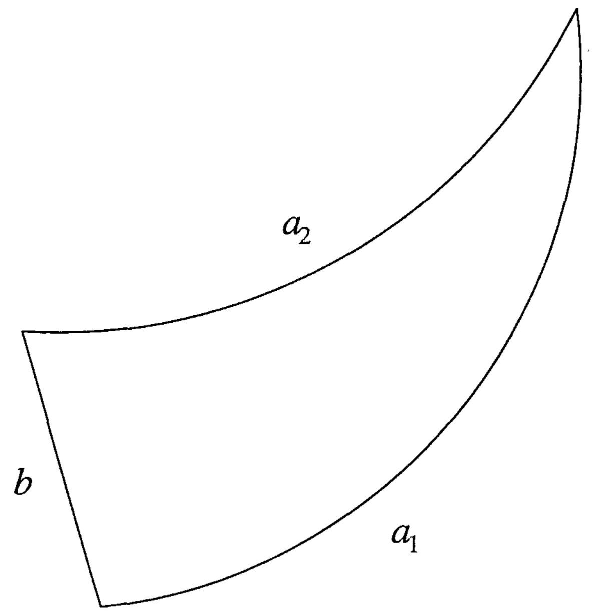


Figure 2.2: The Ivory-Like Figure (*karidantakṣetra*) of the Elder Bhāskara

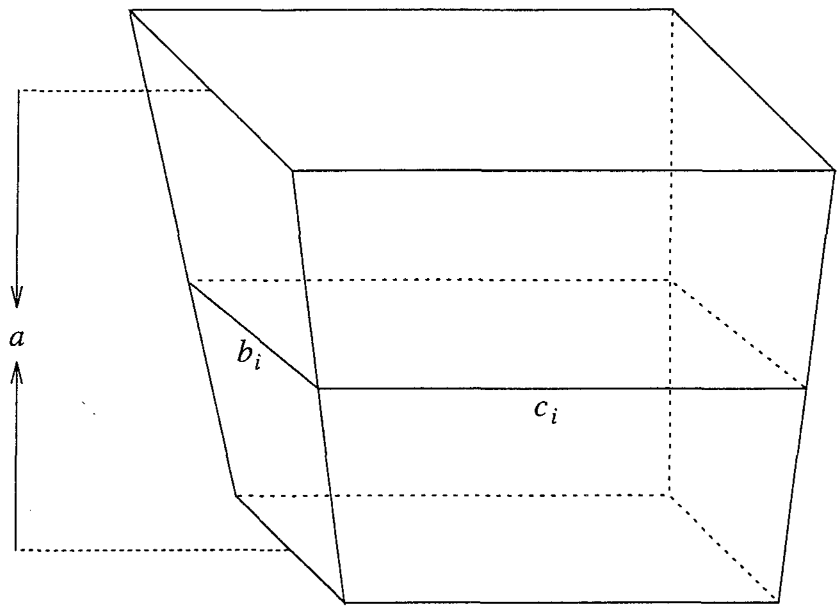


Figure 2.3: Rectangular Ditch with Irregular Sides (*viṣamakhāta*)

The word *karman* ('work') used to denote the volume in the example is probably related to the word *karmāntika* ('of workmen') of the GSS:

bāhyābhyantarasaṃsthitatattatkṣetrasthabāhukoṭibhuvaḥ /
svapratibāhusametā bhaktās tatkṣetragaṇanayānyonyam //9//
guṇitāś ca vedhaguṇitāḥ karmāntikasaṃjñagaṇitaṃ syāt //10ab//

⟨Suppose⟩ a side, an upright, and ⟨in the case of a triangle⟩ a base as located in each ⟨sectional⟩ figure situated between the top and the bottom (lit. the outside and the inside) ⟨of a rectangular or triangular ditch⟩. ⟨Out of these three kinds of sides⟩, one ⟨kind⟩ (lit. oneself) and the corresponding ⟨kind of⟩ sides are summed up ⟨severally⟩, divided ⟨each⟩ by the number of those ⟨sectional⟩ figures ⟨measured⟩, and multiplied by each other. ⟨The result⟩, being multiplied by the depth, will be the value named the *karmāntika*.

That is, the volume called *karmāntika* of a rectangular ditch (Figure 2.3) is:

$$V = a \cdot \frac{b_1 + b_2 + \cdots + b_n}{n} \cdot \frac{c_1 + c_2 + \cdots + c_n}{n},$$

where a is the depth (*vedha*), and b_i and c_i are respectively the side (*bāhu*) and the upright (*koṭi*) of the i-th horizontal section of the ditch. This approximate volume, with $n = 2$, is called *vyavahārikagaṇita* ('practical value') by Brahmagupta (BSS 12.45).

Example 1 (V 5–6).

Given: $a_1 = 200,\ a_2 = 100.\ b_1 = 5,\ b_2 = 7,\ b_3 = 10,\ b_4 = 12,\ b_5 = 15,\ b_6 = 20.\ c_1 = 1,\ c_2 = 2,\ c_3 = 3,\ c_4 = 5,\ c_5 = 7.$ (Measure unkown)

Solution: $a = \frac{200+100}{2} = 150,\ b = \frac{5+7+10+12+15+20}{6} = \frac{23}{2},\ c = \frac{1+2+3+5+7}{5} = \frac{18}{5}.\ V = 150 \cdot \frac{23}{2} \cdot \frac{18}{5} = 6210.$

The text then calculates the price of the thing (meat?) by means of a *trairāśika* (see Sūtra C10), which is based on the idea that one *ṭalla* (= 32 or 64 *maṇḍalakas*) of that thing costs one monetary unit, which is not specified in the text. If one adopts the relation: 1 ṭalla = 64 *maṇḍalakas*, Price = $T(1\ \textit{ṭalla}, 1, 6210\ \textit{maṇḍalakas}) = T(64\ \textit{maṇḍalakas}, 1, 6210\ \textit{maṇḍalakas}) = 97\frac{1}{32}$ monetary units. If one adopts the other change-ratio, 32 : 1, then the price would be $194\frac{1}{16}$ monetary units.

Sūtra N15 (VI 1–3)
A system of linear equations

Type of problem:
The problem is a system of linear equations with $(2n + 1)$ unknown numbers.

$$x_1 + x_2 = p_1 \qquad (1)$$
$$\cdots$$
$$x_i + x_{i+1} = p_i \qquad (i)$$
$$\cdots$$
$$x_{2n+1} + x_1 = p_{2n+1} \qquad (2n+1)$$

Rule:
Suppose $x_1 = a$, and compute the value of x_{i+1} successively by using the equations:

$$x_{i+1} = p_i - x_i \qquad (i)'$$

At the end of this procedure, another value of x_1 is obtained by:

$$x_1' = p_{2n+1} - x_{2n+1} = b \qquad (2n+1)'$$

Then, the true value of x_1 is obtained by:

$$x_1 = \frac{a+b}{2}.$$

Remarks:
The *sūtra* takes it for granted that the rest of the unknown numbers can be calculated by using equation $(i)'$, for $i = 1, 2, \cdots, 2n$.

This rule may be proved thus. The above procedure leading to the false value b of x_1 can be expressed as:

$$\begin{aligned} b &= p_{2n+1} - x_{2n+1} \\ &= p_{2n+1} - (p_{2n} - x_{2n}) \\ &= \cdots \\ &= \{p_{2n+1} - p_{2n} + \cdots + (-1)^{i+1} p_i + \cdots - p_2 + p_1\} - a. \end{aligned}$$

On the other hand,

$$\begin{aligned} x_1 &= p_1 - x_2 \\ &= p_1 - (p_2 - x_3) \\ &= \cdots \\ &= \{p_1 - p_2 + \cdots + (-1)^{i+1} p_i + \cdots - p_{2n} + p_{2n+1}\} - x_1. \end{aligned}$$

Therefore,

$$x_1 = \frac{a+b}{2}.$$

Note that, if the number of equations be even $(2n)$, the system is indeterminate.

Example 1 (VI 1).

Given: $x_1 + x_2 = 13,\ x_2 + x_3 = 14,\ x_3 + x_1 = 15$.

Solution: Suppose $x_1 = 5$, then $x_2 = 13 - 5 = 8,\ x_3 = 14 - 8 = 6$, and $x_1' = 15 - 6 = 9$. Hence, $x_1 = \frac{5+9}{2} = 7$, and $x_2 = 6,\ x_3 = 8$.

Example 2 (VI 2–3).

Given: $x_1 + x_2 = 16,\ x_2 + x_3 = 17,\ x_3 + x_4 = 18,\ x_4 + x_5 = 19,\ x_5 + x_1 = 20$.

Suppose $x_1 = 10$, then $x_2 = 16 - 10 = 6,\ x_3 = 17 - 6 = 11,\ x_4 = 18 - 11 = 7,\ x_5 = 19 - 7 = 12$, and $x_1' = 20 - 12 = 8 = 9$. Hence, $x_1 = \frac{10+8}{2} = 9$, and $x_2 = 7,\ x_3 = 10,\ x_4 = 8,\ x_5 = 11$.

Verification: $x_1 + x_2 = 9 + 7 = 16$, etc.

Sūtra N16 (VI 4)
An indeterminate equation of the second degree

Type of problem:

$$xy = ax + by$$

Rule:

$$\begin{cases} x = b + 1 \\ y = ab - 1 + (a + 1) \end{cases} \quad \begin{cases} x = ab - 1 + (b + 1) \\ y = a + 1 \end{cases}$$

Remarks:
The problem and the rule have been restored from the extant example.

The somewhat awkward expression of the solutions is apparently a device either for arriving at the two solutions simultaneouly, or for economizing on the verbal expression of the rule or on the actual computational process, or for both.

This type of equation, which contains the product (xy) of two unknown numbers, is specifically called *bhāvita* ('the produced') in Indian mathematics. The general case of the *bhāvita*-type of equations: $axy = bx + cy + d$, is solved in BSS 18.60, SS 14.20–21, and BG 185. GSS miśraka 284 gives a solution to the equation: $(a \pm x)(b \pm y) = c$.

Example 1 (VI 4).
Given: $xy = 3\,x + 4\,y$.
Solution: $x = 4 + 1 = 5,\ y = 3 \cdot 4 - 1 + (3 + 1) = 15;\ x = 3 \cdot 4 - 1 + (4 + 1) = 16,\ y = 3 + 1 = 4$.

Sūtra N17 (VI 4)
An indeterminate equation of the second degree(?)

Remark:
The terminology suggests that this *sūtra* also treats the so-called *bhāvita*-type of equations, but the rule cannot be restored. No example is preserved. Cf. Sūtra N16 above.

Sūtra N18 (VII 1–10)
Period of an arithmetical progression

Type of problem:
When the first term (a), common difference (d), and sum (S) of an arithmetical progression are given, what is the number (n) of terms in that series?

$$S = \left\{ \frac{(n-1)d}{2} + a \right\} \cdot n$$

Rule:

$$n = \frac{\sqrt{8\,dS + (2a - d)^2} - (2a - d)}{2\,d}$$

Remarks:
The same, or equivalent, rule is given in AB 2.20, BSS 12.18, PG 87 = Tr 41, GSS parikarman 69–70 and kalāsavarṇa 33–34, MS 15.50–51, SS 13.24, and L 128.

Reconciliation process in the verification. In the extant examples of our text, the solution goes step by step according to the *sūtra*.

When the sum is multiplied by eight	$8S$
and the common difference,	$8dS$
twice the first term	$2a$
is decreased by the common difference,	$2a-d$
and squared.	$(2a-d)^2$
When one has added ⟨the square⟩ to it,	$8dS+(2a-d)^2\ (=K)$
the square root	$\sqrt{K}\ (=p)$
is decreased by its square root,	$p-(2a-d)$
and divided by twice the common difference.	$\frac{p-(2a-d)}{2d}\ (=n)$

The verification of the answer (n), which is called *pratyānayana* ('the counter-computation') instead of *pratyaya* throughout in this section, is made by means of the 'Minus-One' method (Sūtra Q12):

$$S(n)=\left\{\frac{(n-1)d}{2}+a\right\}\cdot n=S\ \text{(given)}.$$

In those examples, however, the number K that occurs in the process of solution is always found to be a non-square number, and its approximate root is employed in the succeeding steps. The answer is, therefore, obtained as an approximation (n'). Hence,

$$S(n')-S=e\neq 0.$$

This error (e), which originates from the approximation of $\sqrt{K}\ (=p)$, is calculated in the course of the root-extraction and preserved for the verification: see the number 21743271936 in (VII 9) and (VII 10). Or, otherwise, a factor of the error is kept somewhere on the calculating board until the error is required for the verification: see the statements, *śeṣaṃ catvāriṃśa pṛthak sthāpya* ('The remainder, forty, should be placed separately') in (VII 1), *catvāriṃśānāṃ pṛthaksthānāṃ* ('of the forty, which has been placed separately') in (VII 2), and *śeṣaṃ paṃcakaṃ pṛthak sthāpya* ('The remainder, five, should be placed separately') in (VII 5). Thus, in any case, the verification ascertains the correctness of the answer by showing:

$$S(n')-e=S.$$

This reconsiliation is made mechanically in a specific manner which is closely connected with the method of the root-approximation given in Sūtra Q2.

Let p_i ($i=1,2,3$) be the i-th approximation of p ($=\sqrt{K}$) that is prescribed in Sūtra Q2:

$$p=\sqrt{K}=\sqrt{p_1^2+E}$$
$$p_2=p_1+\frac{E}{2p_1}$$
$$p_3=p_1+\frac{E}{2p_1}-\frac{\frac{1}{2}\cdot\left(\frac{E}{2p_1}\right)^2}{p_1+\frac{E}{2p_1}}.$$

Let n_i be the value of n corresponding to p_i $(i = 2, 3)$:

$$n_i = \frac{p_i - (2a - d)}{2d}.$$

Then we have:

$$S(n_i) - S(n) = \frac{p_i^2 - K}{8d}.$$

On the other hand,

$$p_2^2 - K = \left(\frac{E}{2p_1}\right)^2$$

$$p_3^2 - K = \left\{\frac{E^2}{4p_1(2p_1^2 + E)}\right\}^2.$$

Hence the error e_i $(i = 2, 3)$ caused by the i-th approximation (p_i):

$$e_2 = S(n_2) - S(n) = \frac{E^2}{32p_1^2 d}$$

$$e_3 = S(n_3) - S(n) = \frac{E^4}{128p_1^2(2p_1^2 + E)^2 d}.$$

Let us now examine the denominator of $S(n_i)$. In the case of the second approximation (p_2), the answer to the problem is:

$$n_2 = \frac{p_2 - (2a - d)}{2d} = \frac{A}{4p_1 d} \quad \text{where } A = 2p_1^2 + E - 2p_1(2a - d).$$

The verification is made step by step according to the 'Minus-One' method (Sūtra Q12):

$$n_2 - 1 = \frac{A}{4p_1 d} - 1 = \frac{B}{4p_1 d} \quad \text{where } B = A - 4p_1 d,$$

$$\frac{(n_2 - 1)d}{2} = \frac{\left(\frac{B}{4p_1 d}\right) \cdot d}{2} = \frac{B}{8p_1},$$

$$\frac{(n_2 - 1)d}{2} + a = \frac{B}{8p_1} + a = \frac{C}{8p_1} \quad \text{where } C = B + 8p_1 a,$$

$$\left\{\frac{(n_2 - 1)d}{2} + a\right\} \cdot n_2 = \frac{C}{8p_1} \cdot \frac{A}{4p_1 d} = \frac{AC}{32p_1^2 d} = S(n_2).$$

Thus, if we do not cancel any number in the fractions except d at the second step of the verification, $S(n_2)$ will have the denominator, $32p_1^2 d$, which is equal to the denominator of e_2 obtained above. So, in the actual process of computation, we do not have to pay attention to the denominator of the error, but only have to memorize E (or E^2), which is obtained as a by-product in the course of the root-extraction, and to subtract E^2 from the numerator of $S(n_2)$ at the last step of the verification. This is exactly what is done in the text, which keeps fractions unreduced for this purpose.

Likewise, both $S(n_3)$ and e_3 will have the same denominator, $128p_1^2(2p_1^2 + E)d$, unless we reduce the fractions except d at the second step of the verification. Thus, the text simply subtracts E^4

from the numerator of $S(n_3)$ at the last step without referring to its denominator. We may express the numerator of e_i by $\overline{e}_i$:

$$\overline{e}_2 = E^2$$
$$\overline{e}_3 = (E^2)^2 = E^4.$$

These values are called *karaṇi* or 'a square number' in the text (VII 10).

If E is an even number, p_i may be obtained in the forms:

$$p_2 = p_1 + \frac{E'}{p_1}$$
$$p_3 = p_1 + \frac{E'}{p_1} - \frac{\frac{1}{2}\cdot\left(\frac{E'}{p_1}\right)^2}{p_1 + \frac{E'}{p_1}},$$

where $E' = \frac{E}{2}$. In these cases, we must take:

$$\overline{e}_2 = E'^2,$$
$$\overline{e}_3 = E'^4.$$

The latter case actually occurs in Example 1 and, with a slight modification, in Example 4.

If K is found to be a fraction, it is rewritten in the form:

$$K = \frac{K'}{f^2},$$

and the approximate root, p_2 or p_3, of K' is obtained. This, however, has no effect on the method of the reconciliation. This case occurs in Examples 3 and 4.

Example 1 (VII 1–4).

Given: $a = d = 1,\ S = 60$.

Solution 1, which employs the second approximation, p_2, of $\sqrt{K}$: $K = 8\cdot 1\cdot 60 + (2\cdot 1 - 1)^2 = 481 = 21^2 + 40$. $p_1 = 21,\ E = 40$. $p_2 = 21 + \frac{40}{42} = \frac{882}{42} + \frac{40}{42} = \frac{922}{42}$. $n_2 = \left(\frac{922}{42} - 1\right) \div 2 = \frac{880}{84}$.

Verification: $S\left(\frac{880}{84}\right) = \left\{\left(\frac{880}{84} - 1\right)\cdot 1 \div 2 + 1\right\}\cdot\frac{880}{84} = \frac{964}{168}\cdot\frac{880}{84} = \frac{848320}{14112}$. $\overline{e}_2 = 40^2 = 1600$. $S(n_2) - e_2 = \frac{848320-1600}{14112} = 60 = S$.

Solution 2, which employs the third approximation, p_3, of $\sqrt{K}$:

$$\begin{aligned}
p_2 &= 21 + \frac{40}{42} = 21 + \frac{20}{21}.\\
p_3 &= 21 + \frac{20}{21} - \left(\frac{20}{21}\right)^2\cdot\left(\frac{1}{2}\right) \div \left(21 + \frac{20}{21}\right)\\
&= \frac{461}{21} - \frac{400}{21}\cdot\frac{1}{2}\cdot\frac{1}{461}\\
&= \frac{425042}{19362} - \frac{400}{19362} = \frac{424642}{19362}.\\
n_3 &= \left(\frac{424642}{19362} - 1\right) \div 2 = \frac{405280}{38724}.
\end{aligned}$$

Verification:

$$\begin{aligned}
S(n_3) &= \left\{\left(\frac{405280}{38724}-1\right)+2\right\}\cdot\frac{1}{2}\cdot\frac{405280}{38724}\\
&= \frac{444004}{38724}\cdot\frac{1}{2}\cdot\frac{405280}{38724}\\
&= \frac{444004}{77448}\cdot\frac{405280}{38724}\\
&= \frac{179945941120}{2999096532}.\\
\bar{e}_3 &= 20^4 = 160000.\\
S(n_3)-e_3 &= \frac{179945941120-160000}{2999096532}\\
&= \frac{179945781120}{2999096532} = 60 = S.
\end{aligned}$$

Remarks. The computation of n_3 in Solution 2 is lost. Note that in the verification of Solution 2 the sum of the progression, $S(n_3)$, is computed by means of the formula:

$$S(n) = \frac{(n-1)d+2\,a}{2}\cdot n,$$

instead of the 'Minus-One' method (Sūtra Q12).

Example 2 (VII 5–7).

Given: $a=d=1,\ S=5.$

Solution 1, which employs the second approximation, p_2, of $\sqrt{K}$: $K = 8\cdot1\cdot5+(2\cdot1-1)^2 = 41 = 6^2+5.$ $p_1=6,\ E=5.$ $p_2 = 6+\frac{5}{12} = \frac{77}{12}.$ $n_2 = \left(\frac{77}{12}-1\right)\div 2 = \frac{65}{24}.$

Verification: $S(n_2) = \left\{\left(\frac{65}{24}-1\right)\cdot 1\div 2+1\right\}\cdot\frac{65}{24} = \left(\frac{41}{48}+1\right)\cdot\frac{65}{24} = \frac{89}{48}\cdot\frac{65}{24} = \frac{5785}{1152}.$ The rest is lost. $\langle \bar{e}_2 = 5^2 = 25.\ S(n_2)-e_2 = \frac{5785-25}{1152} = \frac{5760}{1152} = 5 = S.\rangle$

Solution 2, which employs the third approximation, p_3, of $\sqrt{K}$:

$$\begin{aligned}
p_2 &= 6+\frac{5}{12}.\\
p_3 &= 6+\frac{5}{12}-\left(\frac{5}{12}\right)^2\cdot\left(\frac{1}{2}\right)\div\left(6+\frac{5}{12}\right)\\
&= 6+\frac{5}{12}-\frac{25}{144}\cdot\frac{1}{2}\cdot\frac{12}{77}\\
&= 6+\frac{5}{12}-\frac{25}{1848}\\
&= 6+\frac{770}{1848}-\frac{25}{1848}\\
&= 6+\frac{745}{1848} = \frac{11833}{1848}.\\
n_3 &= \left(\frac{11833}{1848}-1\right)\div 2 = \frac{9985}{3696}.
\end{aligned}$$

Verification (mostly lost):

$$S(n_3) = \left\{\left(\frac{9985}{3696}-1\right)\cdot 1\div 2+1\right\}\cdot\frac{9985}{3696}$$

$$\begin{aligned}
&= \frac{136604785}{27320832}. \\
\bar{e}_3 &= 5^4 = 625. \\
S(n_3) - e_3 &= \frac{136604785 - 625}{27320832} \\
&= \frac{136604160}{27320832} = 5 = S.
\end{aligned}$$

Example 3 (VII 8, only the verification is preserved).
Given: $a = d = \frac{3}{2}$, $S = 2$.
Solution, which employs the third approximation, p_3, of $\sqrt{K}$:

$$\begin{aligned}
K &= 8 \cdot \frac{3}{2} \cdot 2 + \left\{2 \cdot \frac{3}{2} - \frac{3}{2}\right\}^2 = \frac{105}{4} = \frac{10^2 + 5}{2^2}. \\
K' &= 10^2 + 5. \\
f &= 2. \\
p'_3 &= 10 + \frac{5}{20} - \left(\frac{5}{20}\right)^2 \cdot \frac{1}{2} \div \left(10 + \frac{5}{20}\right) = \frac{84025}{8200}. \\
p_3 &= \frac{p'_3}{f} = \left(\frac{84025}{8200}\right) \div 2 = \frac{84025}{16400}. \\
n_3 &= \left\{\frac{84025}{16400} - \left(2 \cdot \frac{3}{2} - \frac{3}{2}\right)\right\} \div \left(2 \cdot \frac{3}{2}\right) \\
&= \left(\frac{84025}{16400} - \frac{3}{2}\right) \div 3 = \frac{59425}{49200}.
\end{aligned}$$

Verification:

$$\begin{aligned}
S(n_3) &= \left\{\left(\frac{59425}{49200} - 1\right) \cdot \frac{3}{2} \cdot \frac{1}{2} + \frac{3}{2}\right\} \cdot \frac{59425}{49200} \\
&= \left(\frac{10225}{49200} \cdot \frac{3}{2} \cdot \frac{1}{2} + \frac{3}{2}\right) \cdot \frac{59425}{49200} \\
&= \left(\frac{10225}{32800} \cdot \frac{1}{2} + \frac{3}{2}\right) \cdot \frac{59425}{49200} \\
&= \left(\frac{10225}{65600} + \frac{3}{2}\right) \cdot \frac{59425}{49200} \\
&= \frac{108625}{65600} \cdot \frac{59425}{49200} \\
&= \frac{6455040625}{3227520000}. \\
\bar{e}_3 &= 5^4 = 625. \\
S(n_3) - e_3 &= \frac{6455040625 - 625}{3227520000} \\
&= \frac{6455040000}{3227520000} = 2 = S.
\end{aligned}$$

Example 4 (VII 8–10).
Given: $a = d = \frac{3}{2}$, $S = 7000$.

Solution, which employs the third approximation, p_3, of $\sqrt{K}$:

$$
\begin{aligned}
K &= 8 \cdot \frac{3}{2} \cdot 7000 + \left(2 \cdot \frac{3}{2} - \frac{3}{2}\right)^2 = \frac{336009}{4} = \frac{579^2 + 768}{2^2}. \\
K' &= 579^2 + 768. \\
f &= 2. \\
p_3' &= 579 + \frac{768}{1158} - \left(\frac{768}{115}\right)^2 \cdot \left(\frac{1}{2}\right) \div \left(579 + \frac{768}{1158}\right) \\
&= 579 + \frac{768}{1158} - \left(\frac{768}{115}\right)^2 \cdot \frac{1}{2} \cdot \frac{1158}{671250} \\
&= 579 + \frac{768}{1158} - \frac{294912}{1158} \cdot \frac{1}{671250} \\
&= 579 + \frac{768}{1158} - \frac{294912}{777307500} \\
&= 579 + \frac{515520000}{777307500} - \frac{294912}{777307500} \\
&= 579 + \frac{515225088}{777307500} = \frac{450576267588}{777307500}. \\
p_3 &= \frac{p_3'}{f} = \frac{450576267588}{1554615000}. \\
n_3 &= \left\{\frac{450576267588}{1554615000} - \left(2 \cdot \frac{3}{2} - \frac{3}{2}\right)\right\} \div \left(2 \cdot \frac{3}{2}\right) \\
&= \frac{448244345088}{4663845000}.
\end{aligned}
$$

Verification:

$$
\begin{aligned}
S(n_3) &= \left\{\left(\frac{448244345088}{4663845000} - 1\right) \cdot \frac{3}{2} \cdot \frac{1}{2} + \frac{3}{2}\right\} \cdot \frac{448244345088}{4663845000} \\
&= \left(\frac{443580500088}{4663845000} \cdot \frac{3}{2} \cdot \frac{1}{2} + \frac{3}{2}\right) \cdot \frac{448244345088}{4663845000} \\
&= \left(\frac{221790250044}{1554615000} \cdot \frac{1}{2} + \frac{3}{2}\right) \cdot \frac{448244345088}{4663845000} \\
&= \left(\frac{110895125022}{1554615000} + \frac{3}{2}\right) \cdot \frac{448244345088}{4663845000} \\
&= \frac{113227047522}{1554615000} \cdot \frac{448244345088}{4663845000} \\
&= \frac{50753383762746743271936}{7250483394675000000}. \\
\bar{e}_3 &= \left(\frac{768}{2}\right)^4 = 21743271936. \\
S(n_3) - e_3 &= \frac{50753383762746743271936 - 21743271936}{7250483394675000000} \\
&= \frac{50753383762725000000000}{7250483394675000000} = 7000 = S.
\end{aligned}
$$

Remark. The computation of n_3 in the solution is lost. The $\bar{e}_3$ has been computed in the course of the solution. See the beginning of (VII 9).

Sūtra N19 (X 26)

Vertical arrangement of the three terms of the *trairāśika*

Type of problem:
The ratio of x to c is equal to that of b to a.

$$a : b = c : x$$

Rule:

$$x = \frac{bc}{a}$$

Remarks:
The *sūtra* itself is much mutilated, but, judging from the two extant examples, it seems to prescribe vertical arrangement of the three terms of the *trairāśika*, which are usually arranged horizontally.

$$\begin{array}{|c|} a \\ b \\ c \\ \hline \end{array}$$

See Sūtra C10 for the normal arrangement and the notation used in this Commentary. Cf. also Sūtra Q11 for another arrangement of the three terms.

Example 1 (X 26). A money-number *trairāśika*: price of tin (*trapusa*).
Given: $a = 1$ *dramma*, $b = 100$ pieces, $c = \frac{1}{2}$ *dramma*.
Solution: $x = T\left(1, 100, \frac{1}{2}\right) = 50$ pieces.

Example 2 (X 26). A money(?)-number *trairāśika*.'
Given: $a = 2\frac{1}{2},\ b = 3,\ c = \frac{3}{2}\left(1 + \frac{1}{2}\right).$
Solution: $a = \frac{5}{2},\ c = \frac{9}{4}.\ x = T\left(\frac{5}{2}, 3, \frac{9}{4}\right) = \frac{27}{10}.$

CHAPTER 3

Conjectured Sūtras

This chapter contains the *sūtras* whose existence is conjectured but which cannot be restored verbally. They are Sūtras C1–C10.

Sūtra C1 (I 7–8)
Rule of inversion

Type of problem:
An unknown number (x) is modified by a series of arithmetical operations (F_i), and the resulting quantity (a) is known.

$$xF_1F_2 \cdots F_{n-1}F_n = a$$

Rule:
Let F_i^{-1} be the inverse operation of F_i.

$$x = aF_n^{-1}F_{n-1}^{-1} \cdots F_2^{-1}F_1^{-1}$$

Remarks:
The rule of inversion (*viparītakarman*) solves problems by applying the inverse operations to the result of a series of operations in the inverse order.

It is not certain which operations are taken into consideration by the present *sūtra*. In order to solve the extant example, the four fundamental operations will suffice.

The elder Āryabhaṭa (AB 2.28) prescribes the rule only for the four fundamental operations:

$$\begin{aligned} &\text{If } x+b=a, \text{ then } x=a-b.\\ &\text{If } x-b=a, \text{ then } x=a+b.\\ &\text{If } x\cdot b=a, \text{ then } x=a/b.\\ &\text{If } x/b=a, \text{ then } x=a\cdot b.\end{aligned}$$

Brahmagupta (BSS 18.14) adds the two operations:

$$\begin{aligned} &\text{If } x^2=a, \text{ then } x=\pm\sqrt{a}.\\ &\text{If } \sqrt{x}=a, \text{ then } x=a^2.\end{aligned}$$

Brahmagupta is followed by Śrīdhara (PG 78), by Mahāvīra (GSS miśraka 286), by the younger Āryabhaṭa (MS 15.23), and by Śrīpati (GT 83 = SS 13.13). The younger Bhāskara (L 49) further adds the two operations:

$$\text{If } x+\frac{c}{b}\cdot x=a, \text{ then } x=a-\frac{c}{b+c}\cdot a.$$
$$\text{If } x-\frac{c}{b}\cdot x=a, \text{ then } x=a+\frac{c}{b-c}\cdot a.$$

Example 1 (I 7–8): a traveling merchant.

Given: $2(x_1-1)-2=x_2,\ 2(x_2-2)-3=x_3,\ 2(x_3-3)-4=x_4,\ 2(x_4-4)-5=0.$

Solution: $x_4=(0+5)/2+4=\frac{13}{2},\ x_3=\left(\frac{13}{2}+4\right)/2+3=\frac{33}{4},\ x_2=\left(\frac{33}{4}+3\right)/2+2=\frac{45}{8}+\frac{16}{8}=\frac{61}{8},\ x_1=\left(\frac{61}{8}+2\right)/2+1=\left(\frac{61}{8}+\frac{16}{8}\right)/2+1=\left(\frac{77}{8}\right)/2+1=\frac{77}{16}+\frac{16}{16}=\frac{93}{16}.$

Verification: in the order of the statement of the problem. $2\left(\frac{93}{16}-1\right)-2=\frac{61}{8}=x_2,\ 2\left(\frac{61}{8}-2\right)-3=\frac{33}{4}=x_3,\ 2\left(\frac{33}{4}-3\right)-4=\frac{13}{2}=x_4,\ 2\left(\frac{13}{2}-4\right)-5=0.$

Remarks. Note that the Statement in the text has already been arranged for the rule of inversion. This problem may be expressed in general terms as:

$$\begin{cases} p\,(x_i-a_i)-b_i=x_{i+1} & (i=1,2,\cdots,n-1)\\ x_n=0 \end{cases}$$

A similar problem of a traveling merchant occurs in BG 101:

$$\begin{cases} p\,(x_i-a)-b=x_{i+1} & (i=1,2,\cdots,n-1)\\ x_n=qx_1 \end{cases}$$

Cf. GSS miśraka $111\frac{1}{2}$, which treats the problem:

$$\begin{cases} a_ix_i-b_i=x_{i+1} & (i=1,2,\cdots,n-1)\\ x_n=0 \end{cases}$$

Sūtra C2 (I 9)
Earnings and donation

Remark:
This *sūtra* treats exactly the same problem as Sūtra 53.

Example 1 (I 9, only the verification is preserved).

Given: $a_1=\frac{7}{2}$ *drammas*, $t_1=2$ days, $a_2=\frac{5}{2}$ *drammas*, $t_2=3$ days, $c=7$ *drammas*.

Solution: $t=(2\cdot 7)/\left\{\left(\frac{7}{2}\right)/2-\left(\frac{5}{2}\right)/3\right\}=\frac{168}{11}$ days.

Verification: $f\left(\frac{168}{11}\right)=T\left(2,\frac{7}{2},\frac{168}{11}\right)-7=\frac{294}{11}-7=\frac{217}{11}$ *drammas*. $g\left(\frac{168}{11}\right)=T\left(3,\frac{5}{2},\frac{168}{11}\right)+7=\frac{140}{11}+7=\frac{217}{11}$ *drammas*.

Example 2 (I 9).

Given: $a_1=15$ *drammas*, $t_1=4-\frac{1}{4}$ days, a_2 lost, $t_2=\frac{7}{2}$ days, c lost.

Solution: lost.

Sūtra C3 (I 18)
Meeting of two travelers

Type of problem:
A traveler, starting from a place A, goes to another place B with a constant speed v_1. Another traveler, starting simultaneously from B, goes to A with a constant speed v_2. The distance between the two places is D. When do they meet?

$$f(t) = v_1 t$$
$$g(t) = v_2 t$$
$$f(t) + g(t) = D$$

Rule:

$$t = \frac{D}{v_1 + v_2}$$

Remark:
The same formula is given in AB 2.31. Cf. also Sūtra 15 above.

Example 1 (I 18).
Given: $v_1 = \frac{18}{96} = \frac{3}{16}$ *yojana*/day, $v_2 = \frac{25}{100} = \frac{1}{4}$ *yojana*/day, $D = 9$ *yojanas*.
Solution (lost): $t = 9/\left(\frac{3}{16} + \frac{1}{4}\right) = 20\frac{4}{7}$ days = 20 days + 20 *ghaṭikās*.
Verification: $f\left(20\frac{20}{35}\right) = T\left(96, 18, 20\frac{20}{35}\right) = \frac{27}{7}$ *yojanas*. $g\left(20\frac{20}{35}\right) = T\left(100, 25, 20\frac{20}{35}\right) = \frac{36}{7}$ *yojanas*. $f\left(20\frac{20}{35}\right) + g\left(20\frac{20}{35}\right) = 9$ *yojanas*.
Remarks. For the relation, 35 *ghaṭikās* = 1 day, see Remark 1 of Sec. 12.1 in the Introduction. For a similar example, see Ex. 1 given by Bhāskara for AB 2.31.

Sūtra C4 (II 9–10)
Partial subtraction (*bhāgāpavāha*)

Remarks:
This *sūtra* seems to have been either missed or deliberately omitted by the commentator or the scribe, since one example for it immediately follows Example 9 for Sūtra N6, which deals with a comletely different problem. For the *bhāgāpavāha*-type of problem, see Sūtras 25 and 26.

Example 1 (II 9–10).
Given: $x\left(1 - \frac{1}{2}\right)\left(1 - \frac{1}{4}\right)\left(1 - \frac{1}{5}\right) + 280 = x$.
Solution (lost): $x = 400$.
Verification 1: by steps. $400 - \frac{400}{2} = 200,\ 200 - \frac{200}{4} = 150,\ 150 - \frac{150}{5} = 120,\ 120 + 280 = 400$.
Verification 2: *jātikriyā* (see under Sūtras 25 and 26). $280 = x - x\left(1 - \frac{1}{2}\right)\left(1 - \frac{1}{4}\right)\left(1 - \frac{1}{5}\right) = x\left\{\frac{1}{2} + \frac{1}{4}\cdot\left(1 - \frac{1}{2}\right) + \frac{1}{5}\cdot\left(1 - \frac{1}{2}\right)\left(1 - \frac{1}{4}\right)\right\} = \frac{28}{40}x$. Therefore, $x = 280/\left(\frac{28}{40}\right) = 400$.

Sūtra C5 (IV 12)
Proportion in geometry(?)

Remarks:
The problem treated here is related with an equilateral triangle, whose side is measured by 36. Both the left and right sides (*bhuja*, abbreviated *bhu* in the text) of the triangle are divided into nine equal parts, each of which is measured by 4. To these parts correspond eight straight lines drawn parallel to the base of the triangle. Naturally, the lengths of those straight lines form an arithmetical progression, whose first term and the common difference are both 4. This progression is probably related to the two series, one of couplets (Series A) and the other of triplets (Series B), which occur in the statement attached to the geometric figure. Series A is introduced by the phrase, *atha dvau* ('Now, couplets'), and Series B by the phrase, *atha trīṇi* ('Now, triplets').

Series A	Series B
$a_1 = (4, 36)$	$b_1 = (36, 20, 4)$
$a_2 = (8, 32)$	$b_2 = (32, 20, 8)$
$a_3 = (16, 28)$	$b_3 = (28, 20, 12)$
$a_4 = (24, 16)$	$b_4 = (24, 20, 16)$

A comparison of Series A and Series B suggests that a_3 and a_4 are corrupt. Probably their correct values are:

$$a_3 = (12, 28)$$
$$a_4 = (16, 24)$$

Thus, the two series may be expressed as:

$$\begin{cases} a_i = (4 \cdot i, 40 - 4 \cdot i) \\ b_i = (40 - 4 \cdot i, 20, 4 \cdot i) \end{cases} \quad (\text{for } i = 1, 2, 3, 4)$$

In the text, each pair in Series A seems to be followed by the arithmetical mean of the two numbers, that is,

$$\frac{4 \cdot i + (40 - 4 \cdot i)}{2} = 20,$$

for every i ($i = 1, 2, 3, 4$). This number, 20, is given as the middle term of each triplet in Series B.

Cf. GSS kṣetra $175\frac{1}{2}$, which treats a problem of dividing an isosceles trapezium into several small trapeziums in a given ratio by drawing straight lines parallel to the base.

Sūtra C6 (V 3–4)
Proportional distribution

Type of problem:
A given amount (p) is divided into n parts ($A_1, A_2, \cdots, A_n$) in the ratio, $a_1 : a_2 : \cdots : a_n$. When the values of $a_1, a_2, \cdots, a_j$, and those of $A_{j+1}, A_{j+2}, \cdots, A_n$ are given, calculate the values of the rest.

$$a_1 : a_2 : \cdots : a_n = A_1 : A_2 : \cdots : A_n$$
$$A_1 + A_2 + \cdots + A_n = p$$

Rule:

$$a_i = \frac{A_i}{q} \quad (\text{for } i = j+1, j+2, \cdots, n)$$
$$A_i = a_i q \quad (\text{for } i = 1, 2, \cdots, j)$$

where

$$q = \frac{p - (A_{j+1} + A_{j+2} + \cdots + A_n)}{a_1 + a_2 + \cdots + a_j}.$$

Remark:
The same rule is given in GSS miśraka 222.

Example 1 (V 3–4).

Given: $n = 7, a_1 = 10, a_2 = 12, a_3 = 14, a_4 = 16, a_5 = 18, A_6 = 200, A_7 = 300, p = 1200$.

Solution: $q = \frac{1200-(200+300)}{10+12+14+16+18} = 10$. Hence, $A_1 = 100, A_2 = 120, A_3 = 140, A_4 = 160, A_5 = 180$. $\langle a_6 = 20, a_7 = 30.\rangle$ $A_1 + A_2 + \cdots + A_7 = 1200$.

Verification: When each share is calculated by means of the *trairāśika*, $A_i = T(1, q, a_i)$, the sum of A_i (for $i = 1, 2, \cdots, 7$) is the given amount p (=1200).

Remarks. The Solution does not refer to a_6 and a_7.

For a similar example, see GSS miśraka 223–225.

Sūtra C7 (VII 11–12)
Hundred Creatures Problem

Type of problem:
There are n kinds of living creatures, and a_i of the i-th kind cost b_i. When the total number p of those are bought for q, how many of each kind are obtained?

$$x_1 + x_2 + \cdots + x_n = p$$
$$\frac{b_1}{a_1}x_1 + \frac{b_2}{a_2}x_2 + \cdots + \frac{b_n}{a_n}x_n = q$$

Rule:
Unknown.

Remarks:
There is no clue for restoring the rule of this *sūtra*. The same problem is treated by Śrīdhara (PG 63–64), Mahāvīra (GSS miśraka $146\frac{1}{2}$ and 151), and the younger Bhāskara (BG 138).

Śrīdhara solves this problem thus. The 'Statement' is given in the form:

$$a_1y_1 + a_2y_2 + \cdots + a_ny_n = p$$
$$b_1y_1 + b_2y_2 + \cdots + b_ny_n = q,$$

where

$$\frac{x_i}{a_i} = y_i,$$

although the unknown y_i's are not actually written down. Then, from these equations, Śrīdhara obtains a single equation by eliminating y_j:

$$\begin{aligned}\frac{a_j}{b_j}q - p &= \left(\frac{a_j b_1}{b_j} - a_1\right) y_1 + \cdots + \left(\frac{a_j b_{j-1}}{b_j} - a_{j-1}\right) y_{j-1} \\ &\quad + \left(\frac{a_j b_{j+1}}{b_j} - a_{j+1}\right) y_{j+1} + \cdots + \left(\frac{a_j b_n}{b_j} - a_n\right) y_n.\end{aligned}$$

Then, he solves this indeterminate equation by trial and error (*svabuddhyā*, lit. 'by one's own intellect'). Once a set of solution, $(y_i)_{i\neq j} = (u_i)_{i\neq j}$, is obtained, then, as he says, a set of solutions of the original equations is obtained by:

$$\begin{cases} x_i = a_i u_i \quad \text{for } i \neq j \\ x_j = p - (x_1 + \cdots + x_{j-1} + x_{j+1} + \cdots + x_n). \end{cases}$$

Bhāskara (BG 138) solves the same problem by means of *anekavarṇasamīkaraṇa* or 'equations with more than one unknown.' It is mathematically equivalent to Śrīdhara's algorithm. Mahāvīra's two algorithms for the same problem are considerably different from that of Śrīdhara. See Raṅgācārya's note on his translation, pp. 132–133.

Example 1 (VII 11).
Remark. Too mutilated to be restored. The only certain thing is that $q = 20$ *maṇḍakās*.

Example 2 (VII 11): monkeys, horses, and deer.
Given: $x_1 + x_2 + x_3 = 20,\ ax_1 + 4x_2 + \frac{1}{2}x_3 = 20$ *paṇas*. (The coefficient a is lost.)
Solution: Too mutilated to be restored, but $x_2 = 3$.
Remark. The extant portion of the Computation gives: $x_2 = 3$. Therefore, we have:

$$\begin{cases} x_1 + x_3 = 17 \\ ax_1 + \frac{1}{2}x_3 = 8. \end{cases}$$

By eliminating x_3, we have: $x_1 = \frac{1}{1-2a}$. Since $1 \leq x_1 \leq 16$, we have: $0 \leq a \leq \frac{15}{32} < \frac{1}{2}$. If $a = \frac{1}{3}$, then $(x_1, x_2, x_3) = (3, 3, 14)$; if $a = \frac{1}{4}$, then $(x_1, x_2, x_3) = (2, 3, 15)$; and so on.

Example 3 (VII 12): men, girls, and *śūdras*.
Given: $x_1 + x_2 + x_3 = 20,\ 3x_1 + \frac{3}{2}x_2 + \frac{1}{2}x_3 = 20$ *maṇḍas*.
Solution: $(x_1, x_2, x_3) = (2, 5, 13)$.
Remarks. The Computation does not seem to give a working process.
For a similar example, see PG Ex. 78–79 = GSS miśraka 152–153 = BG 138 = PM A21 (pigeons, cranes, swans, and peacocks):

$$\begin{cases} x_1 + x_2 + x_3 + x_4 = 100 \\ \frac{5}{3}x_1 + \frac{7}{5}x_2 + \frac{9}{7}x_3 + \frac{3}{9}x_4 = 100 \quad \textit{rūpas} \text{ (coins)}. \end{cases}$$

This example of pigeons, etc., seems to have been quite popular in medieval India. The anonymous commentator on the PG (p. 82) cites a mnemonic verse, which tells how to make a table of integer solutions to it.

See also PG Ex. 80 (pomegranates, mangoes, and wood apples):

$$\begin{cases} x_1 + x_2 + x_3 = 100 \\ 2\,x_1 + \frac{3}{5}x_2 + \frac{1}{2}x_3 = 80 \;\; \textit{rūpas}\,; \end{cases}$$

GSS miśraka $147\frac{1}{2}$–149 (peacocks, pigeons, swans, and cranes):

$$\begin{cases} x_1 + x_2 + x_3 + x_4 = 72 \\ \frac{3}{2}x_1 + \frac{4}{3}x_2 + \frac{5}{4}x_3 + \frac{6}{5}x_4 = 56 \;\; \textit{paṇas}\,; \end{cases}$$

and GSS miśraka 150 (ginger, long pepper, and pepper):

$$\begin{cases} x_1 + x_2 + x_3 = 68 \;\; \textit{palas} \\ \frac{5}{3}x_1 + \frac{11}{4}x_2 + \frac{1}{8}x_3 = 60 \;\; \textit{paṇas}. \end{cases}$$

Sūtra C8 (VII 11–12)
Expression of a large number(?)

Remark:
The purpose of this *sūtra* is not known.

Example 1 (VII 13).

This example simply versifies a large number having twenty-seven decimal places. The statement goes from the higher places to the lower, by giving pairs of numbers except the unit place. The number is:

$$26, 53, 29, 62, 26, 44, 70, 64, 99, 4\underline{2}, 83, 21, \underline{1}8, 7.$$

The underlined '2' could be 3 or 6, and the '1' could be 2 or 3 or 6 or 8.

The right-ward move used in the verbal expression of this number is not common in the Indian mathematics, although it is commonly used in Sanskrit and Prakrit literature in combination with numerals such as *koṭi* (10^7), *lakṣa* (10^5), *sahasra* (10^3), and *śata* (10^2).

Sūtra C9 (IX 1–4)
Consumption of income and stock

Remark:
The problem here treated and the formula used in the examples are the same as those of Sūtra 52, but the present examples involve reduction of a number of fractions.

Example 1 (IX 1–2).

Given: $a = \left(1\frac{1}{2}\right) / \left(1\frac{1}{3}\right)$ *vajjaras*/day, $b = 8/\left(5\frac{1}{3}\right) + \frac{1}{32} + \left(2\frac{1}{4}\right) \cdot \left(\frac{1}{4}\right)/36$ *vajjaras*/day, $c = 700$ *vajjaras*.

Solution: $a = \frac{9}{8}$ *vajjaras*/day, $b = \frac{223}{144}$ *vajjaras*/day. $t = 700/\left(\frac{223}{144} - \frac{9}{8}\right) = \frac{280}{61}$ years = 4 years + 7 months $+2\frac{28}{61}$ days.

Verification 1: $f(t) = T\left(\frac{4}{3}, \frac{3}{2}, \frac{280}{61} \cdot 360\right) + 700 = 1859\frac{1}{61} + 700 = 2559\frac{1}{61}$ *vajjaras*. $g(t) = T\left(1, \frac{223}{144}, \frac{280}{61} \cdot 360\right) = 2559\frac{1}{61}$ *vajjaras*.

Verification 2: $b = T\left(t, g(t), \frac{1}{360}\right) = T\left(\frac{280}{61}, 2559\frac{1}{61}, \frac{1}{360}\right) = \frac{223}{144}$ *vajjaras*/day.

Example 2 (IX 2–4).

Given: $a = \left(10\frac{1}{2}\right) / \left(2\frac{1}{3}\right)$ *vajjaras*/day, $b = \left(13\frac{1}{3}\right) / \left(3\frac{1}{8}\right) + \left(13 - \frac{1}{4}\right) / \left(8\frac{1}{2}\right) + \left(1\frac{1}{3}\right) / \left(3\frac{1}{5}\right) + \left(\frac{1}{2}\right) / \left(1\frac{1}{2}\right) + 1/\left(5\frac{1}{3}\right) + \left(2\frac{1}{4}\right) \cdot \left(\frac{1}{4}\right) / \left(1\frac{1}{4}\right) + \left(12\frac{1}{2}\right) / \left(33\frac{1}{3}\right)$ *vajjaras*/day. $c = 1200$ *vajjaras*.

Solution (lost): $a = \frac{9}{2}$ *vajjaras*/day, $b = \frac{1807}{240}$ *vajjaras*/day, $t = 1200/\left(\frac{1808}{240} - \frac{9}{2}\right) = \frac{800}{727}$ years.

Verification 1: $f(t) = T\left(\frac{7}{3}, \frac{21}{2}, \frac{800}{727} \cdot 360\right) + 1200 = 1782\frac{486}{727} + 1200 = 2982\frac{486}{727}$ *vajjaras*, $g(t) = T\left(1, \frac{1807}{240}, \frac{800}{727} \cdot 360\right) = 2982\frac{486}{727}$ *vajjaras*.

Verification 2: $b = T\left(t, g(t), \frac{1}{360}\right) = T\left(\frac{800}{727}, 2982\frac{486}{727}, \frac{1}{360}\right) = \frac{1807}{240}$ *vajjaras*/day.

Example 3 (? IX 4).

Remark. The only legible word is *udā*, the abbreviation of *udāharaṇa* ('an example').

Sūtra C10 (X 1–25)
The rule of three (*trairāśika*)

Type of problem: When x is to c just as b is to a, what is x?

$$a : b = c : x$$

Rule:

$$x = \frac{bc}{a}$$

Remarks:

The *trairāśika*, which literally means 'of three quantities,' is a rule for computing the unknown x from the three given quantities, a, b, and c, when the ratio of x to c is equal to that of b to a. The three given quantities are usually arranged horizontally in an enclosure having three cells, and this is followed by the answer.

a	b	c	phalaṃ d /

where $d = x$. For differennt arrangements of the three terms, see Sūtras N19 and Q11.

Trairāśika has been prescribed by almost all Indian mathematicians known to us. See AB 2.26, BSS 12.10, PG 43 = Tr 29, GSS trairāśika 2, MS 15.24–25ab, GT 86 = SS 13.14, and L 73. They attached a great importance to *trairāśika*. Bhāskara goes on to say thus:

> *asti trairāśikaṃ pāṭī bījaṃ ca vimalā matiḥ* (L 64).
>
> *Pāṭī* (algorithm) is *trairāśika*, and *bīja* ('seed') is stainless intellect.

The same phrase occurs also in his *Golādhyāya* 13.3.

As most Indian mathemtaicians point out, the quantities, a and c, must have the same denomination, which is usually, but not necessarily, different from the denomination that the quantity b has.

I will express a *trairāśika* determined by three quantities, a, b, and c, by $T(a, b, c)$:

$$x = T(a, b, c) = \frac{bc}{a}.$$

Also, I will call this relation 'A-B *trairāśika*,' where A and B designate respectively the category of measure for a and c, and that for b and x. The measures used in this section can be classified into the following categories: the number (of articles), time, arc, length (or distance), area, money, and weight.

Example 1 (X 1–2). Time-weight *trairāśika*: refinement of the metal called *mahāśobhana* (probably gold).

Given: $a = 1$ day, $b = 3$ *tolas* + 2 *māṣas* + 3 *aṇḍikās* + 3 *yavas* + 1 *kalā* + 1 *pāda* + 1 *mūdṛkā* − (4 *raktis* + 4 *siddhārthas*), $c = 25$ years + 5 months + 20 days.

Solution: $b = \frac{62321}{19200}$ *tolas* $- \frac{3}{40}$ *tolas* $= \frac{60881}{19200}$ *tolas*, $c = 9170$ days. $x = T(a, b, c) = \frac{bc}{a} = \frac{60881}{19200} \cdot 9170$ *tolas* $= \frac{60881}{19200} \cdot 9170 \cdot \frac{1}{7} \cdot \frac{1}{2000}$ *bhāras* $= \frac{558278770}{268800000}$ *bhāras* = 2 *bhāras* + 153 *palas* + 6 *tolas* + 3 *yavas* + 4 *kalās* + 1 *pāda* + 2 *mūdṛkās*.

Remarks. In this solution, the unusual relation, 7 *tolas* = 1 *pala*, is used instead of the ordinary one, 8 *tolas* = 1 *pala*.

When the first or second term of the *trairāśika* contains a negative quantity as in the present example, the problem is called *gatinivṛtti* ('going forward and backward'), and an additional rule is given for it by Śrīdhara (PG 44ab), Mahāvīra (GSS trairāśika 23), and the younger Āryabhaṭa (MS 15.30). Cf. also PM A22, which is cited verbatim from PG 44ab. Śrīdhara prescribes thus:

> *tyaktvaikadinanivṛttiṃ divasagater ekadinagatiḥ śeṣaḥ* (PG 44ab).
>
> On subtracting the backward motion per day from the forward motion per day, the remainder is the ⟨true⟩ motion per day. (Trans. by Shukla 1959)

For other problems of this type, see Exs. 9, 16, 19, 24, and 37 below. For similar examples, see also Ex. 4 given by Bhāskara for AB 2.26, PG Exs. 32 and 33, and GSS trairāśika 24–31.

Example 2 (X 2). Weight-money *trairāśika*: price.

Given: $a = 1$ *tola*, $b = 400$ *dīnāras*, $c = 1$ *dhānaka* + 1 *aṇḍikā* + 1 *rakti* + 1 *yava* + 1 *kalā* + 1 *pāda* + 1 *mūdṛkā*.

Solution: $a = 12$ *dhānakas*, $c = \frac{2441}{1600}$ *dhānakas*. $x = T\left(12, 400, \frac{2441}{1600}\right) = \frac{2441}{48}$ *dīnāras* = 50 *dīnāras* + 10 *dhāṇas* +1 *aṇḍikā*.

Example 3 (X 3). Weight-money *trairāśika*: price.

Given: $a = 1$ *tola*, $b = 5\frac{1}{3}$ *vajjaras*, $c = 1$ *tola* + 1 *dhānaka* + 1 *aṇḍikā* + 1 *rakti* + 1 *yava* + 1 *siddhārtha* + 1 *kalā* + 1 *pāda* + 1 *mūdṛkā*.

Solution: $c = \frac{21681}{19200}$ *tolas*. $x = T\left(1, \frac{16}{3}, \frac{21681}{19200}\right) = \frac{7227}{1200}$ *vajjaras* = 6 *vajjaras* + 7 *pālāhatas* + $2\frac{9}{10}$ *śvetikās*.

Remark. The reduction of the third term (c) to the weight, *tola*, is made in two different ways. See under Sūtra Q6.

Example 4 (X 4). Weight-money *trairāśika*: price.

Given: $a = 1$ *tola*, $b = 35$ *drammas*, $c = \frac{3}{2}$ *tolas* + $\frac{3}{2}$ *māṣakas* + $\frac{3}{2}$ *aṇḍikās* + $\frac{3}{2}$ *yavas*.

Solution: $c = \frac{213}{128}$ *tolas*. $x = T\left(1, 35, \frac{213}{128}\right) = 58\frac{31}{128}$ *drammas*.

Remarks. As in the previous example (Ex. 3), the reduction of the third term (c) to the weight, *tola*, is made in two different ways. Note also that the price, 35 *drammas/tola*, is close to that of Ex. 3, that is, $\frac{16}{3}$ *vajjaras/tola* (= 32 *drammas/tola*).

Example 5 (X 5). Weight-weight *trairāśika*: a certain thing (whose name is missing) and gold.

Given: $a = \left(1 + \frac{1}{4}\right) \cdot 20$ *raktis*, $b = 1$ *dhāṇa* + $4\frac{1}{4}$ *yavas*, $c = 1$ *suvarṇa* + 1 *rakti*.

Solution: $a = 25$ *raktis*, $b = \frac{81}{64}$ *dhāṇas*, $c = 81$ *raktis*. $x = T\left(25, \frac{81}{64}, 81\right) = \frac{6561}{1600}$ *dhāṇas* = 4 *dhāṇas* + 1 *yava* + 3 *kalās* + 3 *pādas* + 1 *mūdṛkā*.

Remarks. This example and the following may belong to one and the same problem, as the introductory remarks to them suggest. Note also that no verbal statement is given for Example 6.

Example 6 (X 5). Weight-weight *trairāśika*: a certain thing and gold.

Given: $a = \left(2 + \frac{1}{4}\right) \cdot 20$ *raktis*, $b = \frac{1}{3}$ *draṅkṣaṇa* + $\frac{1}{2} \cdot \frac{1}{2}$ *dhāṇa*, $c = 1$ *suvarṇa* + 1 *rakti*.

Solution: $a = 45$ *raktis*, $b = \frac{145}{384}$ *draṅkṣaṇa*, $c = 81$ *raktis*. $x = T\left(45, \frac{145}{384}, 81\right) = \frac{783}{1152}$ *draṅkṣaṇa* = 4 *dhāṇas* + 1 *yava* + 1 *kalā* + 2 *pādas* + 1 *mūdṛkā*.

Remark. The reduction of the middle term (b) to the weight, *draṅkṣaṇa*, is made in an unusual way, for which see under Sūtra Q6.

Example 7 (X 5). Arc(?)-time *trairāśika*.

Given: a lost, $b = 13\frac{5}{9}$ days, and c lost.

Example 8 (X 6). Length-time *trairāśika*.

Given: $a = 64$ *aṅgulas*, $b = 1$ year, $c = 1$ *yojana*.

Solution: $c = 768000$ *aṅgulas*. $x = T(64, 1, 768000) = 12000$ years.

Example 9 (X 6). Length-time *trairāśika*: a moving snake.

Given: $a = \frac{1}{2}\left(1 + \frac{1}{9}\right) - \frac{1}{21}$ *aṅgulas*, $b = 1$ day, $c = 18$ *hastas*.

Solution: $a = \frac{32}{63}$ *aṅgula*, $b = \frac{1}{360}$ year, $c = 432$ *aṅgulas*. $x = T\left(\frac{32}{63}, \frac{1}{360}, 432\right) = \frac{189}{80}$ years = 2 years + 4 months + 10 days + 15 *muhūrtas*.

Remarks. This is a typical example of the *gatinivṛtti* problem. See under Ex. 1 above.

The elder Bhāskara (under AB 2.26) gives a similar example of a moving snake, in which $a = \frac{1}{2} - \frac{1}{5}$ *aṅgula*, $b = 1$ *muhūrta*, and $c = 20$ *hastas*.

Mahāvīra (GSS trairāśika 31) also gives a similar example of a moving snake, in which $a = 21 - 11$ *aṅgulas*, $b = 1$ day, and $c = 32$ *hastas*.

Another example of a moving snake, which is strikingly similar to the above (Example 9 for Sūtra C10), is given in PM A23, in which $a = \frac{1}{2}\left(1 + \frac{1}{9}\right) - \frac{1}{20}$ *aṅgulas*, $b = 1$ day, $c = 18$ *hastas*. See Appendix G.

Example 10 (X 6). Length-time *trairāśika*: a moving worm.

Given: $a = \frac{1}{2}$ *aṅgula*, $b = 1$ day, $c = 25$ (+ d?) ⟨*yojanas*?⟩.

Solution (lost): If we assume $c = 25$ *yojanas*, i.e., 19200000 *aṅgulas*, $x = T\left(\frac{1}{2}, \frac{1}{360}, 19200000\right) = \frac{320000}{3}$ years = 106666 years + 8 months.

Example 11 (X 7).

Given: a is lost, b seems to be $9\frac{1}{2}$, and $c = 1$ *vā* (or *va*?) = 9 *gu*.

Remark. The two abbreviations used in this example have not been identified.

Example 12 (X 7). Number-money *trairāśika*: instruction fees to spiritual teachers (*gurus*).

Given: $a = 1,\ b = \left(\frac{1}{2}\right)^6$ *dīnāra*, $c = 108$.

Solution: $x = T\left(1, \left(\frac{1}{2}\right)^6, 108\right) = \frac{27}{16}$ *dīnāras* = 1 *dīnāra* + 8 *dhāṇas* + 1 *aṇḍikā*.

Remark. The stanza itself does not explicitly mention the number, 108, as if there were a consensus that the number of *gurus* is always 108.

Example 13 (X 7). Area-number *trairāśika*: hairs on a skin.

Given: $a = \left(\frac{1}{2}\right)^2$ square *aṅgula*, $b = 900,\ c = 12^2$ square *hastas*.

Solution: $c = 82944$ square *aṅgulas*. $x = T\left(\frac{1}{4}, 900, 82944\right) = 298598400$ hairs.

Example 14 (X 8). Weight-time *trairāśika*.

Given: $a = 1$ *pāda*, $b = 1$ day, $c = 12$ *ghaṭikās*.

Solution: $b = \frac{1}{360}$ year, $c = 40320$ *pādas*. $x = T\left(1, \frac{1}{360}, 40320\right) = 112$ years.

Example 15 (X 8). Length-time *trairāśika*: a climber of Mount Meru.

Given: $a = \left(7 + \frac{1}{2}\right)\left(1 + \frac{1}{4}\right)\left(1 - \frac{1}{2}\right)\left(1 + \frac{1}{3}\right)\left(1 + \frac{3}{5}\right)$ *yojanas*, $b = 1$ day, $c = 84000$ *yojanas*.

Solution: $a = 10$ *yojanas*, $b = \frac{1}{360}$ year. $x = T\left(10, \frac{1}{360}, 84000\right) = 23$ years + 4 months.

Example 16 (X 9). Length-number *trairāśika*: turning-backs of the garment thrown by Sītā.

Given: $a = \frac{6}{5} - \frac{1}{10}$ *dhanus'*, $b = 1$ turning-back, $c = 30$ *yojanas*.

Solution: $a = \frac{11}{10}$ *dhanus'*, $c = 240000$ *dhanus'*. $x = T\left(\frac{11}{10}, 1, 240000\right) = 218181\frac{9}{11}$ turning-backs.

Remark. This example is based on the episode of Sītā's abduction by Rāvaṇa told in *Rāmāyaṇa* 3.52.1–5. See Sec. 13.2.2 of the Introduction.

Example 17 (X 9). A problem of a snake (*nāga*).

Remark. Probably, Ex. 17 = Ex. 18.

Exampe 18 (X 10). Length-time *trairāśika*.

Given: $a = \frac{1}{2}$ *aṅgula*, $b = 1$ day, $c = 100$ *yojanas* + 6 *krośas* + 3 *hastas* + 5 *aṅgulas*.

Solution: $b = \frac{1}{360}$ year, $c = 77376077$ *aṅgulas*. $x = T\left(\frac{1}{2}, \frac{1}{360}, 77376077\right) = 429867$ years + 1 month + 4 days.

Example 19 (X 10). Length-time *trairāśika*: a garment fallen from Brahmaloka ('Brahman's World').

Given: $a = 300 - 7$ *yojanas*, $b = 1$ day, $c = 146500000$ *yojanas*.

Solution (lost): $a = 293$ *yojanas*. $x = T(293, 1, 146500000) = 500000$ days =1388 years + 10 months + 20 days.

Example 20 (X 11). Number(?)-length *trairāśika*.
Given: $a = 10,\ b = 14$ *krośas*, $c = 15$.
Solution: $x = T(10, 14, 15) = 21$ *krośas*.

Example 21 (X 11). Number-weight *trairāśika*: salt.
Given: $a = 1$ lump, $b = 1075$ *palas*, $c = 56$ lumps.
Solution: $x = T(1, 1075, 56) = 60200$ *palas* = 30 *bhāras* + 200 *palas*.

Example 22 (X 11). Time-money *trairāśika*: donation.
Given: $a = 1$ day, $b = \frac{1}{10} \cdot \frac{1}{18} \cdot \frac{1}{20} \cdot \frac{1}{100}$ *kākiṇī*, $c = 100$ years.
Solution (lost): $b = \frac{1}{360000}$ *kākiṇī*, $c = 36000$ days. $x = T\left(1, \frac{1}{360000}, 36000\right) = \frac{1}{10}$ *kākiṇī*.

Example 23 (X 12). Length-time *trairāśika*: a moving worm.
Given: $a = 3$ *yavas*, $b = 1$ day, $c = 5$ *yojanas*.
Solution: $b = \frac{1}{360}$ year, $c = 2304000$ *yavas*. $x = T\left(3, \frac{1}{360}, 2304000\right) = 21333$ years + 4 months.
Remarks. Since 6 *yavas* = 1 *aṅgula*, the given speed of the worm, 3 *yavas*/day, is exactly the same as that given in Ex. 10 above.
For similar examples of a moving worm, see PG Ex. 31 = Tr 36 and GSS trairāśika 5.

Example 24 (X 12). Length-time *trairāśika*: a sailing ship.
Given: $a = \frac{1}{3} \cdot \frac{1}{2} \cdot \left(1 + \frac{1}{3}\right) \cdot \left(1 - \frac{1}{4}\right) \cdot \frac{1}{3} \cdot \left(1 + \frac{1}{3}\right) - \left(\frac{1}{5} \cdot \frac{1}{2} + \frac{1}{8}\right) \cdot \frac{1}{3}$ *yojanas*, $b = 1$ day, $c = 108$ *yojanas*.
Solution: $a = \frac{3}{10}$ *yojanas*, $b = \frac{1}{360}$ year. $x = T\left(\frac{3}{10}, \frac{1}{360}, 108\right) = 1$ year.
Remark. A similar example of a sailing ship occurs in GSS trairāśika 24–25.

Example 25 (X 13). Weight-number *trairāśika*: birds eating grain.
Given: $a = 1$ *prasṛti*, $b = 11$ birds, $c = 8$ *khārīs*.
Solution: $c = 5760$ *prasṛtis*. $x = T(1, 11, 5760) = 63360$ birds.

Example 26 (X 13). Time-weight *trairāśika*: donation of gold to Śiva.
Given: $a = 1$ day, $b = 1$ *yava* + 1 *kalā* + 1 *pāda*, $c = 5$ years + 1 month + 15 days.
Solution: $b = \frac{6}{5}$ *yavas*, $c = 1845$ days. $x = T\left(1, \frac{6}{5}, 1845\right) = 2214$ *yavas* = 11 *tolas* + 6 *dhāṇas* + 1 *aṇḍikā* + 2 *yavas*.

Example 27 (X 14). Length-number *trairāśika*: arrows shot by Arjuna.
Given: $a = \frac{1}{80}\left(1 + \frac{1}{9}\right)\left(1 + \frac{1}{5}\right)$ *krośa*, $b = 1$ arrow, $c = \left(\frac{7}{2}\right)^3 \cdot \frac{1}{7}$ *yojanas*.
Solution: $a = \frac{1}{60}$ *krośas*, $c = 49$ *krośa*. $x = T\left(\frac{1}{60}, 1, 49\right) = 2940$ arrows.

Example 28 (X 14). Weight-money *trairāśika*: price of a diamond.
Given: $a = \frac{3}{2}$ *kuḍavas* $+\frac{1}{2}$ *māṣa*, $b = 55$ *sateras*, $c = \frac{1}{4}$ *māṇa* $+\frac{1}{15}$ *siddhārtha*.
Solution: $a = 7700$ *siddhārthas*, $c = \frac{15R+4}{60}$ *siddhārthas*, where R is the unknown ratio of *māṇa* to *siddhārtha*. $x = T\left(7700, 55, \frac{15R+4}{60}\right) = \frac{15R+4}{8400}$ *sateras*.

Example 29 (X 15). Time-length *trairāśika*: the sun's motion.

Given: $a = 1$ day, $b = 5 \cdot 10^8$ *yojanas*, $c = 1$ *ghaṭikā*.

Solution: $a = 30$ *muhūrtas* = 60 *ghaṭikās*. $x = T(60, 500000000, 1) = 8333333\frac{1}{3}$ *yojanas*.

Remark. The sun's daily motion here given is probably based on a Purāṇic cosmology. See also the next example.

Example 30 (X 15). Time-length *trairāśika*: the sun's motion.

Given: $a = 1$ day, $b = 5 \cdot 10^8$ *yojanas*, $c = 1$ *muhūrta*.

Solution: $a = 30$ *muhūrtas* = 60 *ghaṭikās*. $x = T(30, 500000000, 1) = 16666666\frac{2}{3}$ *yojanas*.

Remark. See Ex. 29 above.

Example 31 (X 16). Time-arc *trairāśika*: Jupiter's motion.

Given: $a = 1$ year, $b = 1$ *rāśi*, $c = 1$ day.

Solution: $b = 108000$ *viliptās*, $c = \frac{1}{360}$ year. $x = T\left(1, 108000, \frac{1}{360}\right) = 300$ *viliptās* = 5 *liptās*.

Remark. This is the commonest of the parameters of Jupiter given in the Indian astronomical text. According to the *Paitāmahasiddhānta* (early fifth century) the mean daily motion of Jupiter is: 0;4,59,9,8,37,23,... See Pingree 1978, Table V.2. See also the next example.

Example 32 (X 16). Time-arc *trairāśika*: Saturn's motion.

Given: $a = \frac{5}{2}$ years, $b = 1$ *rāśi*, $c = 1$ day.

Solution: $b = 108000$ *viliptās* = 1800 *liptās*, $c = \frac{1}{360}$ year. $x = T\left(\frac{5}{2}, 1800, \frac{1}{360}\right) = 2$ *liptās*.

Remark. According to the *Paitāmahasiddhānta*, the mean daily motion of Saturn is: 0;2,0,22, 51,43,54,... See Pingree 1978, Table V.2. See also Ex. 31 above.

Example 33 (X 16). Not restorable.

Remarks. As the name Yudhiṣṭhira suggests, this example may be based on some episode about him told in the *Mahābhārata*.

One of the measures used here seems to be the time.

Example 34 (X 17). Money-weight *trairāśika*.

Given: $a = 1$ *dramma*, $b = \frac{17}{2}$ *ā's* + 1 *tṛ*, $c = 2$ *drammas*.

Solution: $b = \frac{53}{6}$ *ā's*. $x = T\left(1, \frac{53}{6}, 2\right) = \frac{53}{3} = 17$ *ā's* + 2 *tṛ's*.

Remarks. The abbreviations, *ā* and *tṛ*, have not been identified.

The solution in the text is mostly devoted to the reduction of the middle term (b) to the weight, *ā*; Sūtra Q6 is cited for it.

Example 35 (X 18–19). Double *trairāśika*, number-money and money-time: livelihood in a given period.

Given: First *trairāśika* — $a_1 = 1$ person, $b_1 = 8$ *drammas*, $c_1 = 70$ persons. Second *trairāśika* — $a_2 =$ the result of the first *trairāśika*, $b_2 = 42$ days, $c_2 = 8$ *drammas*.

Solution: $x_1 = T(1, 8, 70) = 560$ *drammas*, $x_2 = T(560, 42, 8) = \frac{3}{5}$ day = 18 *muhūrtas*.

Remarks. The purport of the problem may be restored thus.

> If one person can live on eight *drammas* for forty-two days, then how long can seventy persons live on the same amount of money?

It should be remembered that problems of this type are usually solved by means of *vyasta-trairāśika* or the so-called inverse rule of three: $x = T^v(1, 42, 70) = \frac{1 \cdot 42}{70} = \frac{3}{5}$ day = 18 *muhūrtas*, where

$$x = T^v(a, b, c) = \frac{ab}{c}.$$

The inverse rule of three (T^v) is defined by the younger Bhāskara thus:

> *icchāvṛddhau phale hrāso hrāse vṛddhiś ca jāyate,*
> *vyastaṃ trairāśikaṃ tatra jñeyaṃ gaṇitakovidaiḥ* (L 77).
>
> The 'fruit' (x) decreases when the 'desire' (c) increases, and ⟨the fruit⟩ increases when ⟨the desire⟩ decreases. In that case, the inverse rule of three should be known by the experts of mathematics.

For another example of the same type, see Ex. 36 below. A similar use of double *trairāśika* for *vyastatrairāśika* is found in Tr 38 and 39.

Example 36 (X 19). Double *trairāśika*, number-money and money-time: livelihood for a given period.

Given: First *trairāśika* — $a_1 = 1$ person, $b_1 = 6$ *drammas*, $c_1 = 70$ persons. Second *trairāśika* — $a_2 =$ the result of the first *trairāśika*, $b_2 = 30$ days, $c_2 = 6$ *drammas*.

Solution: $x_1 = T(6, 30, 70) = 350$ *drammas*. The rest is lost.

Remarks. See Ex. 35 above for the purport of the problem.

The solution in the text is preserved up to the beginning of the statement of the second *trairāśika*, but the result of the first *trairāśika*, 350 *drammas*, seems to be meaningless. The correct solution would be: $x_1 = T(1, 6, 70) = 420$ *drammas*, $x_2 = T(420, 30, 6) = \frac{3}{7}$ day.

Example 37 (X 20). Time-weight *trairāśika*.

Given: $a = 1$ day, $b = 1$ *rakti* + 1 *yava* + 1 *kalā* + $\frac{4}{3}$ *pādas* $-\frac{1}{8}\left(1 + \frac{1}{3}\right)$ *rakti*, $c = 30\left(1 + \frac{1}{3}\right)$ years + 1 month + 1 day.

Solution: $b = \frac{291}{240}$ *raktis*, $c = 14431$ days. $x = T\left(1, \frac{291}{240}, 14431\right) = \frac{4199421}{240}$ *raktis* $= \frac{4199421}{115200}$ *palas* = 36 *palas* + 3 *tolas* + 7 *dhāṇas* + 2 *aṇḍikās* + 1 *kalā* + 3 *pādas*.

Example 38 (X 21). Double *trairāśika*, number-weight and time-weight: gold begged by people (*brāhmaṇas*?).

Given: First *trairāśika* — $a_1 = 1$ person, $b_1 = 5$ *palas* + 3 *tolas* + 2 *dhāṇas* + 3 *guñjās* + 2 *yavas*, $c_1 = 80000$ persons. Second *trairāśika* — $a_2 = 1$ day, $b_2 =$ the result of the first *trairāśika*, $c_2 = 12$ years.

Solution: $b_1 = \frac{20749}{3840}$ *palas*. $x_1 = T\left(1, \frac{20749}{3840}, 80000\right) = \frac{2593625}{6}$ *palas* $= \frac{20749}{96}$ *bhāras* = 216 *bhāras* + 270 *palas* + 6 *tolas* + 8 *dhāṇas*. $c_2 = 4320$ days. $x_2 = T\left(1, \frac{20749}{96}, 4320\right) = 933705$ *bhāras*.

Remark. The problem may be restored thus.

> If one person begs five *palas*, three *tolas*, two *dhāṇas*, three *guñjās*, and two *yavas* of gold every day, then how much do eighty thousand persons beg in twelve years?

Example 39 (X 21). Not restorable.

Remark. The only extant word, *śirase*, suggests that Ex. 39 = Ex. 40.

Example 40 (X 22). Number-number *trairāśika*: arrows shot against *śiras'*.

Given: $a = 1$ *śiras*, $b = 15$ arrows, $c = 10$ *śiras'*.

Solution: $x = T(1, 15, 10) = 150$ arrows.

Remark. The word *śiras*, which literally means 'a head,' is here used to denote the smallest unit of an army usually called a *patti*. Cf. Ex. 42 below.

Example 41 (X 22). Number-number *trairāśika*: arrows shot against *akṣauhiṇīs*.

Given: $a = 1$ *patti* (or *śiras*), $b = 16\left(1 + \frac{1}{4}\right)\left(1 + \frac{1}{2}\right)$ arrows, $c = 4$ *akṣauhiṇīs*.

Solution: $b = 30$ arrows, $c = 21870 \cdot 4 = 87480$ *pattis*. $x = T(1, 30, 87480) = 2624400$ arrows.

Remark. The *akṣauhiṇī* is the largest unit of an army. See the next example.

Example 42 (X 22–23). Four number-number *trairāśikas*: the size of an *akṣauhiṇī* (the largest unit of an army).

Given: $a_1 = a_2 = a_3 = a_4 = 1$ *patti*, $b_1 = 1$ chariot, $b_2 = 1$ elephant, $b_3 = 5$ foot soldiers, $b_4 = 3$ horses, $c_1 = c_2 = c_3 = c_4 = 1$ *akṣauhiṇī*.

Solution: $c_i = 3^7 \cdot 10$ *pattis* for every $i \quad (i = 1, 2, 3, 4)$. $x_1 = T(1, 1, 3^7 \cdot 10) = 21870$ chariots, $x_2 = T(1, 1, 3^7 \cdot 10) = 21870$ elephants, $x_3 = T(1, 5, 3^7 \cdot 10) = 109350$ foot soldiers, $x_4 = T(1, 3, 3^7 \cdot 10) = 65610$ horses.

Remarks. The stanzas of this example are cited verbatim from *Mahābhārata* 1.2.15–19a, which gives the following relationships among various units of armies:

1 *patti*	=	1 chariot + 1 elephant + 5 foot soldiers + 3 horses
1 *senāmukha*	=	3 *pattis*
1 *gulma*	=	3 *senāmukhas*
1 *gaṇa*	=	3 *gulmas*
1 *vāhinī*	=	3 *gaṇas*
1 *pṛtanā*	=	3 *vāhinīs*
1 *camū*	=	3 *pṛtanās*
1 *anīkiṇī*	=	3 *camūs*
1 *akṣauhiṇī*	=	10 *anīkiṇīs*

The solution given in our text is a mathematical explanation of the succeeding four stanzas (19b–22), which simply versify the numbers of chariots, etc., contained in one *akṣauhiṇī*. See Sec 13.2.1 of the Introduction.

Example 43 (X 23). Not restorable.

Remark. The name of a certain prince, Śatrudamana, occurs.

Exmaple 44 (X 24–25). Weight-money *trairāśika*.

Given: $a = 20\left(1 + \frac{1}{2}\right)\left(1 + \frac{1}{3}\right)$ *bhāras*, $b = 160$ *rūpakas*, $c = 6\left(1 + \frac{1}{2}\right)\left(1 + \frac{1}{2}\right)$ *bhāras*.

Solution 1: Here, the values of a and c are probably obtained by means of the method called *bhāgānubandhajāti*, for which see under Sūtras 25 and 26. $a = 40$ *bhāras*, $c = \frac{27}{2}$ *bhāras*. $x = T\left(40, 160, \frac{27}{2}\right) = 54$ *rūpakas*.

Solution 2: Here, the value of c is probably obtained by means of the ordinary addition of fractions. $a = 40$ *bhāras*, $c\ \langle = 6 + 3 + \frac{6+3}{2} \rangle = 13\frac{1}{2}$ *bhāras*. $x = T\left(40, 160, 13\frac{1}{2}\right) = 54$ *rūpakas*.

Solution 3: Here, the first two terms, a and b, are reduced to smaller terms by 40. $a = 1,\ b = 4$. $x = T\left(1, 4, \frac{27}{2}\right) = 54$ *rūpakas*.

Solution 4: Here, one *trairāśika* is made for each of the three component parts of the third term (c), that is, 6, 3, and $\frac{9}{2}$. $x_1 = T(1, 4, 6) = 24$ *rūpakas*, $x_2 = T(1, 4, 3) = 12$ *rūpakas*, $x_3 = T\left(1, 4, \frac{9}{2}\right) = 18$ *rūpakas*, $x = x_1 + x_2 + x_3 = 54$ *rūpakas*.

Remark. The method employed for Solution 4 is called *pratyekamūlyavidhi* ('individual-price method') in the text. It is based on the identity:

$$T(a, b, c_1 + c_2 + \cdots + c_n) = T(a, b, c_1) + T(a, b, c_2) + \cdots + T(a, b, c_n).$$

CHAPTER 4

Quoted Sūtras

This chapter contains the *sūtras* which are quoted in the Computations of the examples. They are Sūtras Q1–Q12. Most of them are concerned with the fundamental operations.

Sūtra Q1 (VII 1,5,7,9)
Reduction of fractions

Rule:

$$a + \frac{c}{b} = \frac{ab + c}{b}$$

Remarks:
The extant citations are so fragmentary that it is impossible to restore the stanza verbatim, but the rule can be restored with certainty from the contexts where it is cited.

In the Indian way of expression, the rule is:

$$\begin{array}{|c|}\hline a \\ c \\ b \\ \hline\end{array} \longrightarrow \begin{array}{|c|}\hline d \\ b \\ \hline\end{array}$$

where $d = ab + c$.

The same rule is given in BSS 12.9, PG 39 = Tr 24, GSS kalāsavarṇa 113, MS 15.11, GT 48 (p. 34), and L 34, but the phrase, *aṃśas tv aṃśaṃ*, which begins the present *sūtra*, does not occur in these works.

Sūtra Q2 (III 12, VII 3,5,6,7)
Root approximation

Rule:
Let p_1 be an approximate value of $\sqrt{K}$:

$$K = p_1^2 + E.$$

Then, the following p_2 and p_3 are more accurate approximations to $\sqrt{K}$.

$$p_2 = p_1 + \frac{E}{2p_1}$$

$$p_3 = p_2 - \frac{\frac{1}{2} \cdot \left(\frac{E}{2p_1}\right)^2}{p_2}$$

See below for the details of the rule.

Remarks:
This *sūtra* is cited partially in VII 3,5,6, and 7, and at full length in III 12, VII 3, and 6. Although none of the full citations is preserved completely, it can be restored with certainty.

akṛte śliṣṭakṛtyūnāt śeṣacchedo dvisaṃguṇaṃ,
tadvargadalasaṃśliṣṭahṛti śuddhi kṛtikṣayaḥ.

This stanza may be rewritten in regular Sanskrit at the cost of meter thus:

akṛteḥ śliṣṭakṛtyūnāyāḥ śeṣacchedo dvisaṃguṇaṃ ⟨*śliṣṭamūlaṃ*⟩,
tadvargadalasaṃśliṣṭahṛtiḥ śuddhiḥ kṛtikṣayaḥ.

This may be translated and interpreted step by step as follows.

1. Let p_1 be the first approximation (*śliṣṭa*) of a non-square number K.

$$K = p_1^2 + E$$

2. *akṛte . . . dvisaṃguṇaṃ*: 'The divisor for the remainder from the diminution of the non-square number by the square of the first approximation (*śliṣṭa*) is twice ⟨the first approximation (*śliṣṭa*)⟩.'

$$\frac{E}{2p_1}, \quad \text{where } E = K - p_1^2$$

3. The sum of the quotient and the first approximation (*śliṣṭa*) is the second approximation (*saṃśliṣṭa*).

$$p_2 = p_1 + \frac{E}{2p_1}$$

4. *tad . . . hṛti*: 'Division of half the square of that (i.e., the quotient obtained at the second step) by the second approximation (*saṃśliṣṭa*) ⟨is made⟩.'

$$\frac{\frac{1}{2} \cdot \left(\frac{E}{2p_1}\right)^2}{p_2}$$

5. *śuddhi*: 'Subtraction ⟨of the result from the second approximation (*saṃśliṣṭa*) gives the third approximation⟩.'

$$p_3 = p_2 - \frac{\frac{1}{2} \cdot \left(\frac{E}{2p_1}\right)^2}{p_2}$$

6. *kṛtikṣayaḥ*: Two interpretations are possible.

   (a) '⟨The non-square number is⟩ less ⟨than the square of the approximation⟩ by the square ⟨of the last term⟩.'

$$p_2^2 - \left(\frac{E}{2p_1}\right)^2 = K$$

$$p_3^2 - \left\{\frac{\frac{1}{2} \cdot \left(\frac{E}{2p_1}\right)^2}{p_2}\right\}^2 = K$$

(b) In the verification of the answers to the problems under Sūtra N18: 'Subtraction of the square ⟨of the numerator of the last term from the numerator of $S(n_i)$, for $i = 2$ and 3, gives the true value of S⟩.'

$$S(n_i) - e_i = S,$$

where the numerator of e_2 is E^2, and that of e_3 is E^4. See under Sūtra N18.

Although I have supplied two additional steps, the first and third, in the above interpretation, they can be regarded as being included in the second step. The first step is another expression of a part of the second step, and the third, on a calculating board, signifies nothing but the vertical arrangement of the three terms, p_1, E, and $2p_1$.

In the text, the second approximation (p_2) is given by citing the first two *pādas* of the stanza, or otherwise the second *pāda* only, without a working process. See (VII 6) for the former case, and (VII 3) and (VII 5) for the latter. In one place (III 12), the whole stanza is cited when the second approximation is given without, here also, a working process.

Suppose we have obtained the second approximation of $\sqrt{K}$, that is,

$$p_2 = p_1 + \frac{E}{2p_1},$$

which is expressed in the text thus:

$$\left| \begin{array}{c} p_1 \\ E \\ 2p_1 \end{array} \right|$$

Then, the process leading to the third approximation is written down in the text thus (see VII 3 and 6):

$$\textit{tadvarga} \left| \begin{array}{cccccc} p_1 & & & & & p_1 \ \textit{bhā} \\ E & E^2 & \textit{dala} & 1 & \textit{saṃśliṣṭa} & E \\ 2p_1 & 4p_1^2 & & 2 & & 2p_1 + \end{array} \right|$$

Here, the three words, *tadvarga* ('the square of that'), *dala* ('half'), and *saṃśliṣṭa* ('the second approximation,' lit. 'adjoining'), which are cited from the *sūtra*, introduce respectively the three values,

$$\frac{E^2}{4p_1^2}, \quad \frac{1}{2}, \quad \text{and} \quad \left(p_1 + \frac{E}{2p_1}\right)$$

in the enclosure. The abbreviation, *bhā*, for *bhājita* ('divided') or *bhāgahāra* ('a division or a divisor') indicates the division:

$$\frac{E^2}{4p_1^2} \cdot \frac{1}{2} \div \left(p_1 + \frac{E}{2p_1}\right),$$

the operation which is expressed by the word *hṛti* ('division') in the *sūtra*. The negative sign (+) indicates the subtraction (*śuddhi*) of the quotient from the second approximation,

$$\left(p_1 + \frac{E}{2p_1}\right),$$

which is written down at the outset of the enclosure. Thus the above expression in the enclosure exactly corresponds to the computation:

$$\left(p_1 + \frac{E}{2p_1}\right) - \frac{E^2}{4p_1^2} \cdot \frac{1}{2} \div \left(p_1 + \frac{E}{2p_1}\right),$$

or,

$$p_3 = p_2 - \frac{\frac{1}{2} \cdot \left(\frac{E}{2p_1}\right)^2}{p_2},$$

where

$$p_2 = p_1 + \frac{E}{2p_1}.$$

Sūtra Q2 has been commented upon by three modern scholars, G. R. Kaye, B. Datta, and M. N. Channabasappa.

Kaye admitted only the second (or first, according to his terminology) approximation in the *sūtra*. His reading and translation are as follows.

> *akṛte slishṭha kṛtyūnā śesha chchedo dvisaṁgunaḥ,*
> *tad vargaḥ dala saṁslishṭha hṛiti śuddhi kṛti kshayaḥ.*
>
> The mixed surd is lessed by the square portion and the difference divided by twice that. The difference is divided by the quantity and half that squared is the loss. (Kaye 1927/33, 30)

Thus, according to Kaye, Sūtra Q2 prescribes the rule:

$$p_2 = p_1 + \frac{E}{2p_1}$$
$$p_2^2 - K = \left(\frac{E}{2p_1}\right)^2$$

It is Datta who recognized for the first time that the *sūtra* contains a rule for the third approximation (or second, according to Kaye).

> *akṛte śliṣṭa kṛtyūṇā śeṣacchedo dvisaṅgunaḥ,*
> *tad varga dala saṁśliṣṭa hṛti śuddhi kṛti kṣaya.*
>
> In the case of a non-square (number), subtract the nearest square number; divide the remainder by twice (the root of that number). Half the square of that (that is, the fraction just obtained) is divided by the sum of the root and the fraction (*saṃśliṣṭa*) and subtract; (this will be the approximate value of the root) less the square (of the last term). (Datta 1929a, 11)

Thus, according to Datta, Sūtra Q2 prescribes the rule:

$$p_3 = p_1 + \frac{E}{2p_1} - \frac{\left(\frac{E}{2p_1}\right)^2}{2\left(p_1 + \frac{E}{2p_1}\right)}$$
$$p_3^2 - K = \left\{\frac{\left(\frac{E}{2p_1}\right)^2}{2\left(p_1 + \frac{E}{2p_1}\right)}\right\}^2$$

This interpretation is mathematically correct in spite of the loose translation. M. N. Channabasappa tried to remove the grammatical defects found in Datta's translation. But it was not very successful.

> *akṛte śliṣṭakṛtyūnāt śeṣacchedo dvisaṃguṇaḥ,*
> *tadvargadala saṃśliṣṭahṛti śuddhikṛti kṣayaḥ.*
>
> In the case of a number whose square root is to be obtained ⟨*akṛte*⟩, divide it by the approximate root (the root of the nearest square number) ⟨*śliṣṭakṛtyūnāt*⟩; multiply the denominator of the resulting *śeṣa* (the ratio of the remainder to the divisor) by two ⟨*śeṣacchedo dvisaṃguṇaḥ*⟩; square it (the fraction just obtained) ⟨*tadvarga*⟩; halve it ⟨*dala*⟩; divide it by the composite fraction (the first approximation) ⟨*saṃśliṣṭahṛti*⟩; subtract (from the composite fraction) ⟨*kṣayaḥ*⟩; (the result is) the refined root ⟨*śuddhikṛti*⟩. (Channabasappa 1976, 121. The citations in the angled brackets have been supplied by me.)

Thus, according to Channabasappa, the *sūtra* does not mention the error of the approximation. He takes the last word, *kṣaya*, to refer to the subtraction made at the last step of the root extraction. Channabasappa bases his interpretation on forced meanings of the words, *kṛti* ('the square,' lit. 'making') and *ūna* ('diminution,' lit. 'less'). According to him, the former means 'the square root,' and the latter 'the division.' It is doubtful that the words could have such meanings. His arguments concerning those words are not persuasive at all.

My interpretation given above is almost the same as Datta's, except for grammatical details.

Datta's translation shows that he took the word *akṛte* of the *sūtra* to be the locative singular of *akṛta* meaning 'a non-square number.' Since, however, such a meaning of that word has not been attested in any other Sanskrit works, I take it to be *akṛti* in the ablative case, admitting the loss of the *visarga*, a common feature in the language of the BM (see, for example, the gen. sg. *saptate* in III 30).

Datta reads *ūṇā* (misprint for *ūnā*?) at the end of the first *pāda*, but this form is difficult to explain. His translation is ambiguous on this point. I read *ūnāt* in the ablative case, so that it may modify the preceding word *akṛte*, which is also in the ablative case. The form *ūnāt* does occur once in the text (VII 3), as has been correctly noticed by Channabasappa (see his reading cited above). Disagreement in gender is not at all unusuall in the BM (see Sec. 4.2.2 of the Introduction).

According to Datta, *saṃśliṣṭa* means 'the sum of the root and the fraction,' that is, $p_1 + \frac{E}{2p_1}$. This is correct in so far as it is an explanation of what is meant by the word, but does not point to its real meaning and connotation. It is, I think, not a coincidence that the words, *śliṣṭa* ('adhered to') and *saṃśliṣṭa* ('adjoining'), occur successively in the *sūtra*. I interpret them respectively to mean 'a close ⟨value⟩' and 'a closer ⟨value⟩,' or the first and second approximations. These meanings fit well in the context, as my translation shows. The author of the BM, however, who borrowed the *sūtra* from another's work, seems to have been indifferent to such a distinction of the meanings (see *śliṣṭamūlaṃ* in III 12, and *śliṣṭakaraṇyaḥ* in VII 1).

Instead of *dvisaṃguṇaṃ* (neuter), Datta reads *dvisaṃguṇaḥ* (masculine), which would not allow such an interpretation as his (and mine). The word, *śliṣṭamūlam*, is probably understood here.

Sūtra Q3 (VII 3)
Multiplication of fractions

Rule:

$$\frac{b}{a} \cdot \frac{d}{c} = \frac{bd}{ac}$$

Remarks:
Since our text sometimes cites *sūtras* in altered form, it is probable that the present *sūtra* and Sūtra Q7 belong to one and the same *sūtra*.

The same rule is given in BSS 12.3, PG 33ab = Tr 20ab, GSS kalāsavarṇa 2, MS 15.15ab, GT 35 = SS 13.9, and L 39.

Sūtra Q4 (I 10)
Division of fractions

Rule:

$$\frac{b}{a} \div \frac{d}{c} = \frac{bc}{ad}$$

Remark:
The same rule is given in BSS 12.4 and 60, PG 33cd = Tr 20cd, GSS kalāsavarṇa 8, MS 15.15cd, GT 36 = SS 13.10, and L 41.

Sūtra Q5 (X 26)
Not understood

Remarks:
This *sūtra* is cited in the solution of Ex. 2 for Sūtra N19, which prescribes vertical arrangement of the three terms of a *trairāśika* (rule of three). The terminology suggests a rule involving commodities (*paṇya*) and division of fractions.

Sūtra Q6 (X 17)
Reduction of measures

Rule:
See Method 1 below.

Remarks:
Our text exhibits three methods for reducing several measures of one category to the highest of them. Sūtra Q6 prescribes the most popular method, which is called *vallīsavarṇa* ('reduction of a creeper ⟨of fractions⟩') by Śrīdhara (PG 41 = Tr 26cd–27ab), Śrīpati (GT 53, p. 39), and the younger Āryabhaṭa (MS 15.18).

Let there be four quantities, A, B, C, and D, in different measures, m_1, m_2, m_3, and m_4, whose successive conversion-ratios are R_1, R_2, and R_3; and let the sum of the four quantities be S.

$$\begin{aligned} S &= A\,m_1 + B\,m_2 + C\,m_3 + D\,m_4, \quad \text{where} \\ & \quad 1\,m_1 = R_1\,m_2, \;\; 1\,m_2 = R_2\,m_3, \;\; 1\,m_3 = R_3\,m_4. \end{aligned}$$

Method 1 (Sūtra Q6)
The four quantities are arranged vertically together with the conversion-ratios.

$$\begin{array}{|c|} A \\ B \\ R_1 \\ C \\ R_2 \\ D \\ R_3 \\ \hline \end{array}$$

To this 'creeper' of fractions is repeatedly applied the rule:

> Multiply the numerator and the denominator of the first fraction separately by the denominator of the second fraction, and add the numerator of the second fraction to the numerator just obtained.

$$\left.\begin{array}{c} A \\ \frac{B}{R_1} \\ \frac{C}{R_2} \\ \frac{D}{R_3} \end{array}\right\} \longrightarrow \left.\begin{array}{c} \frac{U_1}{T_1} \\ \frac{C}{R_2} \\ \frac{D}{R_3} \end{array}\right\} \longrightarrow \left.\begin{array}{c} \frac{U_2}{T_2} \\ \frac{D}{R_3} \end{array}\right\} \longrightarrow \frac{U_3}{T_3} = S$$

where

$$\left\{\begin{array}{l} U_1 = AR_1 + B \\ T_1 = R_1 \end{array}\right. \quad \left\{\begin{array}{l} U_2 = U_1R_2 + C \\ T_2 = T_1R_2 \end{array}\right. \quad \left\{\begin{array}{l} U_3 = U_2R_3 + D \\ T_3 = T_2R_3 \end{array}\right.$$

The *sūtra* itself is cited only once, but this method is employed very often in the examples for Sūtra C10 (*trairāśika*). It should be noted here that in the unique citation (Ex. 34 for Sūtra C10, in X 17) the meaning of the second *pāda* of the stanza,

> *tacchedam adhe dāpaye.*
>
> One should have its divisor given to the ⟨numerator of the⟩ lower ⟨fraction⟩.

has been altered. This phrase originally prescribes the placement of each conversion-ratio (*cheda*) under the corresponding quantity, but, as is indicated by the words in the two pairs of angled brackets in the above translation, our text forces it to mean the multiplication of B by the denominator of the quantity A, which happens to be a fraction in that example. Thus, according to our text, the *sūtra* prescribes the rule:

$$A + \frac{B}{R_1} = \frac{b}{a} + \frac{B}{R_1} = \frac{bR_1 + aB}{aR_1}.$$

It should be remembered that the verb, *dāpaye* (= Skt. *dāpayet*), which originally means 'one should cause to place or give,' could imply addition, but not multiplication.

Method 2.

The quantities are arranged horizontally together with the reciprocals of the conversion-ratios.

$$\begin{array}{|ccccccc|} A & B & 1 & C & 1 & D & 1 \\ & & T_1 & & T_2 & & T_3 \\ \hline \end{array}$$

where

$$T_1 = R_1, \quad T_2 = R_1R_2, \quad \text{and } T_3 = R_1R_2R_3.$$

This expression exactly corresponds to the computation:

$$S = A + \frac{B}{R_1} + \frac{C}{R_1 R_2} + \frac{D}{R_1 R_2 R_3}.$$

This method is employed in Exs. 3 and 4 for Sūtra C10.

Method 3.
This is used when the quantities are fractions such that:

$$A = \frac{e}{a}, \quad B = \frac{e}{b}, \quad C = \frac{e}{c}, \quad \text{and } D = \frac{e}{d},$$

and when the conversion-ratios are divisible respectively by a, b, and c:

$$ar_1 = R_1, \quad br_2 = R_2, \quad \text{and } cr_3 = R_3.$$

These numbers are arranged in the text thus:

e	
a	
e	1
b	r_1
e	1
c	r_2
e	1
d	r_3

Our text does not show a working process, but the actual computation seems to have been conducted thus.

The denominators of the lower three quantities, b, c, and d, are multiplied severally by r_1, r_2, and r_3, and their numerators, e's, are replaced by unity:

e
a
1
br_1
1
cr_2
1
dr_3

To this column is repeatedly applied the rule:

> Multiply the numerator and the denominator of the penultimate fraction separately by the denominator of the last fraction, and add the product of the numerators of both fractions to the numerator just obtained.

This procedure corresponds to the computation:

$$S = \frac{e}{a}\left[1 + \frac{1}{br_1}\left\{1 + \frac{1}{cr_2}\left(1 + \frac{1}{dr_3}\right)\right\}\right].$$

This method is employed in Exs. 4 and 6 for Sūtra C10.

Sūtra Q7 (IV 7)
Multiplication of fractions

Remark:
This *sūtra* prescribes the same rule as Sūtra Q3.

Sūtra Q8 (I 12)
Not understood

Remark:
The phrase, *ekayutā narasaṃkhy⟨ā⟩*, which seems to begin the present *sūtra*, is exactly the same as the first *pāda* of Sūtra 14, which has not been understood either.

Sūtra Q9 (VII 7)
Sum of an arithmetical progression(?)

Remark:
This is cited once in the verification of the answer to Ex. 2 for Sūtra N18 (period of an arithmetical progression). The phrase, *eko rāśi* ('one quantity'), which begins this *sūtra*, perhaps refers to the period (n) of the progression, which 'is to be put down in two places' (*dvidhā sthāpya*) in the computation of its sum. Cf. Sūtra Q12 below.

Sūtra Q10 (II 1,2)
Addition and subtraction of negative quantities

Rule:

$$a \pm (-b) = a \mp b$$

Remarks:
As has been pointed out by K.S. Shukla 1959, xxix, exactly the same verse (in regular Sanskrit) is cited also by the anonymous commentator on Śrīdhara's PG (pp. 111, 132, and 133).

The same rule occurs also in BSS 18.30–31, SS 14.3, and BG 3 and 7. Cf. Bhāskara's commentary on AB 2.30 (p. 129), where he cites a Prakrit stanza containing a rule for subtraction of negative quantities.

Sūtra Q11 (X 25)
Trairāśika with a special arrangement of the three terms

Rule:

$$x = T^* \left(c, b, \frac{1}{a}\right) = T(a, b, c) = \frac{bc}{a}$$

Remarks:
The citation is so fragmentary that the original stanza cannot be restored, but it probably prescribes

a special arrangement of the three terms of a *trairāśika.* The working process of the extant example seems to suggest the arrangement:

$$\left| \begin{array}{c|c|c} c & b & \frac{1}{a} \end{array} \right| \text{ phalaṃ } d$$

when the ratio of d to c is equal to that of b to a, that is, $a : b = c : d$. The ordinary arrangement (Sūtra C10) is:

$$\left| \begin{array}{c|c|c} a & b & c \end{array} \right| \text{ phalaṃ } d$$

The present rule is introduced as 'another's rule' *(aparasya vidhi)* for *trairāśika.* Cf. Sūtra N19, which prescribes a vertical arrangment of the three terms.

It is noteworthy that the third term of a *trairāśika*, *c*, is here called *śveya* (= Skt. *svīya*) or 'self,' while most Indian mathematicians call it *icchā* or 'requisition, desire.'

Sūtra Q12 (passim)
Sum of an arithmetical progression

Rule:

$$S = \left\{ \frac{(n-1)d}{2} + a \right\} \cdot n,$$

where a, d, n, and S are respectively the first term, common difference, period and sum of the arithmetical progression.

Remarks:
This *sūtra* is referred to by the name *rūpoṇākaraṇa* or the 'Minus-One' method in the text, and is often employed in verifications, although in most cases the actual working process is not given.

The stanza of this *sūtra* has been restored from a few workings in the text (see VII 8 and 10).

The same formula, or its equivalent, is given in AB 2.19, BSS 12.17, PG 85, Tr 39, GSS parikarman 61 and 62, kalāsavarṇa 22, and miśraka 290, MS 15.47, SS 13.20, and L 121.

APPENDIX A

List of Sūtras

A.1 Numbered Sūtras

. . . . /
. . . . *// 1–8 //*[1]
. . . . /
. . . . *// 9 //*[2]
gu⟨ṇau pṛ⟩thagg rūpayutau yācanāyuktisaṃguṇāḥ /
guṇa(gh)nena guṇe(n)ai⟨va⟩ rūpahīnena bhājitau /
viparītayācanākṣiptau guṇasāmye rayaṃ vidhiḥ // 10 //
aṃśāṃ viśoddhya cchedebhya kuryā tatparivartanaṃ /
⟨cheda⟩sāmyaṃ tata projjhya dhanāni śa vinirdiśet // 11 //
. . . . /
. . . . *// 12 //*[3]
deyaṃ vaṇikpiṇḍahataṃ śuddhaṃ ⟨pṛthak svapaṇyataḥ⟩ /
śeṣaparasparābhyāsaṃ svaśeṣeṇa vibhājayet /
⟨svapaṇyaguṇitaṃ yuktaṃ vaṇigbhaktaṃ samaṃ dhanaṃ⟩ // 13 //
ekayutā narasaṃkhyā (dv)i⟨□ □ □ □ □ □ ⟩ .ī □ ca /
evaṃ tāvat kāryaṃ yāvat puruṣai samā bhavati // 14 //
gatisyaiva viśeṣaṃ ca vibhaktaṃ pūrvagantunāḥ /
tenaiva kālaṃ bhavati ssa⟨mena gati⟩(k)⟨e⟩na tu // 15 //
⟨ādy⟩or viśeṣa kartavyaṃ uttarasya viśeṣataḥ /
vibhaktaṃ muttare ⟨□ □ □ □ □ □ □ □ □ □ □ ⟩ // 16 //
ādyor viśeṣa dviguṇaṃ cayaśuddhirvibhājitaṃ /
rūpā⟨dh⟩i⟨kaṃ yadā kā⟩(la)ṃ gatisāmyaṃ tadā bhavet // 17 //
ādyor viśeṣa dviguṇaṃ cayaśuddhivibhājitaṃ /
rūpādhikaṃ yadā kālaṃ dhanasāmyaṃ tadā bhavet // 18 //[4]
dinagamanam ādirahitaṃ ⟨yad⟩ dviguṇaṃ tac cottareṇa saṃyutaṃ /
pratinihita ātmaguṇaṃ j⟨ātaḥ⟩ kṣepasaṃjñako rāśiḥ /
aṣthottarasaṃguṇite kṣepasaṃjñako datvā /
mūlaṃ pratinihi(ta)⟨saṃyutaṃ ca⟩ dviguṇottarabhājitaṃ ⟨ca⟩ // 19 //

1 Missing (unidentified).
2 Unrestorable.
3 Missing (unidentified).
4 Stanza 18 has been restored on the basis of Sūtra 17.

ādiṃ viśoddhya ⟨n⟩i⟨tyata⟩ uttarārdhena bhājitaṃ /
labdhaṃ sarūpa⟨m eṣa ca kālo jñeyaḥ same dhane⟩ // 20 //
dviguṇaṃ prabhavaṃ śuddhaṃ dviguṇān niyatāt tataḥ /
uttareṇa bhajec cheṣaṃ labdhaṃ rūpaṃ vinirdiśet // 21 //
⟨ha⟩yair vibhajya gantavyaṃ ⟨ekarathe 'śva⟩(sa)⟨ṃj⟩ñit⟨ai⟩ /
ekāśvagamana jñ⟨e⟩(ya)⟨ṃ⟩ yukt⟨ai⟩s sa⟨ṃg⟩u⟨ṇ⟩ya ⟨yojane⟩ // 22 //
labdhaṃ dviguṇitaṃ kṛtvā ⟨dviguṇādyūnitaṃ tathā /
uttareṇa⟩ v⟨i⟩bhājitaṃ ⟨saikaṃ p⟩ra⟨ṣ⟩ṇ⟨ā⟩hva⟨yaḥ sa ca⟩ // 23 //
adhvasaṃyogabhaktavyaṃ gantavyaṃ dviguṇaṃ tathā /
mahadalpādhvanos tasmin kāle samāgamo bhavet // 24 //[5]
kṛtvā rūpakṣayaṃ pārthaṃ dhāntaś⟨o⟩ guṇana⟨ṃ⟩ tataḥ /
pravṛttigu⟨ṇanenaiva jātaṃ śeṣaṃ⟩ vinirdiśet // 25 //
kṛtvā rūpakṣayaṃ pārthaṃ dhāntaśo ghātitaṃ tataḥ /
. . . . . // 26 //[6]
kṣayaṃ saṃguṇya kanakās tadyutin bhājayet tataḥ /
saṃyutair eva kanakair ekaikasya kṣayo hi saḥ // 27 //
aprāptasaṃguṇā kaṭī ⟨śuddho hemaghnamā⟩(ṣa)kaḥ /
kā⟨ṃ⟩canai yad bhave labdha⟨ṃ⟩ sa kṣay⟨ā⟩jñātamāśaka⟨ṃ⟩ // 28 //
ūnais saṃguṇya kanakā tatpiṇḍaṃ ca viśodhayet /
suvarṇakanakābhyastā rāśiṣeṣaṃ vibhājayet /
aprāptagaṇḍik⟨ā ⟩(m)āśaśuddhena kanakena tu /
yal labdhaṃ tat pramāṇaṃ tu gaṇḍikāyā vini⟨rdi⟩śet // 29 //
. . . . . /
. . . . . // 30–49 //[7]
yutahīnaṃ ca mekatvaṃ ⟨dvyūnadaladalaṃ kṛtiḥ⟩ /
hīne yutiṃ ca kartavyā ⟨yutahīne sa mūladaḥ⟩ // 50 //
gavāṃ viśeṣa kartavyaṃ dhanaṃ caiva punaḥ ⟨ku⟩ruḥ /
⟨□ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □⟩ // 51 //
āyavyayaviśeṣaṃ tu vibhaktaṃ dṛśyasaṃguṇaṃ /
yal labdhaṃ sā bhavet kālaṃ ayaṃ praṣṭe ⟨vya⟩ye vidhi // 52 //
ahadravya harāśau ta tadviśeṣaṃ vibh⟨ājitaṃ⟩ /
yal labdhaṃ dviguṇaṃ kālaṃ dattā samadhanā prati // 53 //
vi⟨kra⟩yena krayaṃ bhājyaṃ rūpahīnaṃ punar bhajet /
lābhe⟨na⟩ guṇaye tatra nīvī bhavati tatra ca // 54 //
vikrayaṃ bhājaye caiva guṇayet krayapiṇḍatāṃ /
rūpoṇe mūla guṇaye labdha lābhaṃ ca prāpyate // 55 //
vikrayaṃ bhājaye caiva guṇayet krayapiṇḍavat /
vibhaktaṃ sa ca kartavyaṃ guṇaye miśrakaṃ budhaḥ /
yal labdhaṃ sā bhaven mū⟨laṃ⟩ yaś śeṣaṃ lābhapiṇḍatāṃ // 56 //
vikrayaṃ ca vibhaktavyaṃ guṇitaṃ kra⟨yar⟩āśivat /
kṛtvā rūpakṣayaṃ caiva vibhaktaṃ mūlaṃ ⟨ādi⟩sāt // 57 //
vastraśulkaṃ yad bhavati ta⟨dapa⟩hṛtavastrato /

5 Stanza 24 has been restored on the basis of the solution of the extant example.
6 Stanza 26 is a tentative restoration.
7 Missing (unidentified).

trairāśikavidhānena śulka⟨m āna⟩ya tatvataḥ // 58 //
.... /
.... // 59–? //[8]

A.2 Unidentified Sūtras

.... /
.... // N1 //[9]
dinabhaktaviśeṣaṃ ca vi⟨□ □ □ □ □ □ □ ⟩ /
□ *guṇa⟨ṃ k⟩ryate caiva kālam eṣāṃ vinirdiśet* /
trairāśikavidhānena □ ⟨□ □ □ □ □ □ □ ⟩*ṃ* /
ś⟨u⟩l⟨k⟩ā dattaṃ ca pātavyaṃ sūkṣme dattaṃ ca tatsamaṃ // N2 //
⟨□ □ □ □ □ □ □ □ □ □ □ ⟩ □ *cchedasaṃguṇe* /
(a)⟨□ □ □ □ □ □ □ □ ⟩ *ūrdhayutaṃ hṛte phalaṃ* // N3 //
⟨□ □ ⟩*(gu)ṇe tu sadṛśaṃ* ⟨...⟩*y*⟨*e*⟩*t* ⟨.⟩*ṛdyuta* /
bhāgahāra □ □ ⟨□ □ □ □ ⟩ □ ⟨□ ⟩ // N4 //
gatisyaiva viśeṣaṃ tu vibhaktaṃ ⟨*pūrvagantunā,*
guṇam⟩ *anena kāl⟨ena sa⟩(ma)gatī bhaviṣyati* // N5 //
uttarāṃ bhājyato hitvā śeṣāḥ puruṣabhājitāḥ /
⟨□ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ ⟩ // N6 //
.... /
.... // N7 //[10]
śūnyam ekayutaṃ kṛtvā .... /
.... // N8 //
yadṛcchāṃ vinyase śūnye tadā vargaṃ tu kārayet /
⟨*prakṣiptena bhajed dṛśyaṃ prathamaṃ ca vinirdiśet*⟩ // N9 //
kāmikaṃ śūnye vinyastaṃ tadā caiva krame guṇaṃ /
⟨*prakṣiptena bhajed dṛśyaṃ prathamaṃ ca vinirdiśet*⟩ // N10 //
⟨*iṣṭāṅkaṃ vinyase*⟩ *śūnye (yu)taṃ caiva guṇaṃ tataḥ* /
⟨*prakṣiptena bhajed dṛśyaṃ prathamaṃ ca vinirdiśet*⟩ // N11 //
śūnyasthāne rūpaṃ datvā tadanu yuktaṃ guṇita ⟨*h*⟩*ī*⟨*naṃ vā*⟩ /
.... // N12 //
dravyatulyaṃ vinikṣipya kuru prakṣepakaṃ tataḥ /
prakṣ⟨epayukti⟩ saṃsthāpya pṛthag vadha pra⟨kṣepakaiḥ⟩ // N13 //
⟨ .... *niś⟩caya⟨ṃ⟩* /
yatra y⟨o⟩ga⟨ś⟩ ca ⟨ta⟩dbhāga⟨ṃ □ □ □ □ □ □ □ □ □ /
□ □ □ □ □ □ □ □ □ *ta⟩dbhāgaṃ caiva kārayet* /
kṣetravaipulyaḥ r. □ □ *.t.* □ *.y.* ⟨□ □ ⟩ □ ⟨□ □ ⟩ // N14 //
icchāṅkaṃ prathame nyasya tadādīn śodhayet kramāt /
⟨*icchāṅkaśeṣayogārdhaṃ prathamaṃ dhanam*⟩ *ādiśet* // N15 //
pṛthak rūpaṃ vinikṣipya guṇābhyāso rūpahīnaṃ /

8 Missing (unidentified).
9 Lost. But the phrase, *prakṣepayuktyā*, occurs in the examples.
10 Lost. But the phrase, *prakṣepayuktyā*, may be a part of this stanza.

.... // *N16* //
guṇau ⟨□ □ □ □ □ □ □ □ □ ⟩ □ □ □ *k. dhanaṃ* /
guṇābhyāso rūpahīnaṃ labdhaṃ rūpaṃ ⟨□ □ □ □ ⟩ // *N17* //
aṣṭottaraghne gaṇite dviguṇam ādi cayojjhitaṃ /
vargitaṃ tatra nikṣipya mūlaṃ tanmūlavarjitaṃ /
dviguṇottarasaṃbhaktaṃ ⟨*yal labdhaṃ tad bhavet padaṃ*⟩ // *N18* //
⟨..⟩ □ □ □ □ /
□ □ □ ⟨□ □ ⟩ *guṇaye bhājay*⟨*e*⟩ *ekar*⟨*ā*⟩(*ś*)⟨*i*⟩*k*⟨*e*⟩ // *N19* //

A.3 Quoted Sūtras

aṃśas tv aṃśaṃ ... ⟨*upare*⟩ *yojyaṃ* ... // *Q1* //
akṛte śliṣṭakṛtyūnāt śeṣacchedo dvisaṃguṇaṃ /
tadvargadalasaṃśliṣṭahṛti śuddhi kṛtikṣayaḥ // *Q2* //
⟨*adhe*⟩ *adhaṃ upare uparaṃ guṇitavyaṃ* // *Q3* //
adhe uparaṃ guṇaye // *Q4* //
adhenopari saṃguṇya ⟨*apa*⟩*varta krameṇa ca* /
adheṇa ūrdhaṃ guṇaye ma⟨*dhya*⟩*mapaṃyasaṃguṇe* /
bhājaye rlabdhapaṇyaṃ ca (*pa*)⟨□ □ □ □ □ □ □ □ ⟩ // *Q5* //
uparādakṛ⟨*y*⟩*ā k*⟨*āryā*⟩ *tacchedam adhe dāpaye* /
adhenopari saṃgu⟨*ṇya c*⟩*che*⟨*da*⟩*ṃ* ⟨*upari*⟩ *yojayet* // *Q6* //
upare uparaṃ adhe adhaṃ guṇaye // *Q7* //
ekayutā narasaṃkhy⟨*ā*⟩ // *Q8* //
eko rāśi dvidhā sthāpya rūpam ekā⟨...⟩ // *Q9* //
tayor yoga viyogaṃ syā viyoga sati ⟨*saṃgamaḥ*⟩ // *Q10* //
ma⟨*dhyarā*⟩*śi guṇaye* // *Q11* //
rūpoṇā padasaṃkhyā tathottaraghnā dalitādisaṃyutā /
padaghnā ca kāryā yal labdhaṃ tad bhaved gaṇitākhyam // *Q12* //

A.4 Alphabetical List of the Sūtras

aṃśas tv aṃśaṃ ... ⟨*upare*⟩ *yojyaṃ* ... // *Q1* //

aṃśāṃ viśoddhya cchedebhya kuryā tatparivartanaṃ /
⟨*cheda*⟩*sāmyaṃ tata projjhya dhanāni śa vinirdiśet* // *11* //

akṛte śliṣṭakṛtyūnāt śeṣacchedo dvisaṃguṇaṃ /
tadvargadalasaṃśliṣṭahṛti śuddhi kṛtikṣayaḥ // *Q2* //

⟨*adhe*⟩ *adhaṃ upare uparaṃ guṇitavyaṃ* // *Q3* //

adhe uparaṃ guṇaye // *Q4* //

adhenopari saṃguṇya ⟨*apa*⟩*varta krameṇa ca* /
adheṇa ūrdhaṃ guṇaye ma⟨*dhya*⟩*mapaṃyasaṃguṇe* /
bhājaye rlabdhapaṇyaṃ ca (*pa*)⟨□ □ □ □ □ □ □ □ ⟩ // *Q5* //

adhvasaṃyogabhaktavyaṃ gantavyaṃ dviguṇaṃ tathā /
mahadalpādhvanos tasmin kāle samāgamo bhavet // 24 //

aprāptasaṃguṇā kaṭī ⟨śuddho hemaghnamā⟩(ṣa)kaḥ /
kā⟨ṃ⟩canai yad bhave labdha⟨ṃ⟩ sa kṣay⟨ā⟩jñātamāśaka⟨ṃ⟩ // 28 //

aṣṭottaraghne gaṇite dviguṇam ādi cayojjhitaṃ /
vargitaṃ tatra nikṣipya mūlaṃ tanmūlavarjitaṃ /
dviguṇottarasaṃbhaktaṃ ⟨yal labdhaṃ tad bhavet padaṃ⟩ // N18 //

ahadravya harāśau ta tadviśeṣaṃ vibh⟨ājitaṃ⟩ /
yal labdhaṃ dviguṇaṃ kālaṃ dattā samadhanā prati // 53 //

ādiṃ viśoddhya ⟨n⟩i⟨tyata⟩ uttarārdhena bhājitaṃ /
labdhaṃ sarūpa⟨m eṣa ca kālo jñeyaḥ same dhane⟩ // 20 //

⟨ādy⟩or viśeṣa kartavyaṃ uttarasya viśeṣataḥ /
vibhaktaṃ muttare ⟨□ □ □ □ □ □ □ □ □ □ □⟩ // 16 //

ādyor viśeṣa dviguṇaṃ cayaśuddhirvibhājitaṃ /
rūpā⟨dh⟩i⟨kaṃ yadā kā⟩(la)ṃ gatisāmyaṃ tadā bhavet // 17 //

ādyor viśeṣa dviguṇaṃ cayaśuddhivibhājitaṃ /
rūpādhikaṃ yadā kālaṃ dhanasāmyaṃ tadā bhavet // 18 //

āyavyayaviśeṣaṃ tu vibhaktaṃ dṛśyasaṃguṇaṃ /
yal labdhaṃ sā bhavet kālaṃ ayaṃ praṣṭe ⟨vya⟩ye vidhi // 52 //

icchāṅkaṃ prathame nyasya tadādīn śodhayet kramāt /
⟨icchāṅkaśeṣayogārdhaṃ prathamaṃ dhanam⟩ ādiśet // N15 //

⟨iṣṭāṅkaṃ vinyase⟩ śūnye (yu)taṃ caiva guṇaṃ tataḥ /
⟨prakṣiptena bhajed dṛśyaṃ prathamaṃ ca vinirdiśet⟩ // N11 //

uttarāṃ bhājyato hitvā śeṣāḥ puruṣabhājitāḥ /
⟨□ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □⟩ // N6 //

uparādakṛ⟨y⟩ā k⟨āryā⟩ tacchedam adhe dāpaye /
adhenopari saṃgu⟨ṇya c⟩che⟨da⟩ṃ ⟨upari⟩ yojayet // Q6 //

upare uparaṃ adhe adhaṃ guṇaye // Q7 //

ūnais saṃguṇya kanakā tatpiṇḍaṃ ca viśodhayet /
suvarṇakanakābhyastā rāśiṣeṣaṃ vibhājayet /
aprāptagaṇḍik⟨ā⟩(m)āśaśuddhena kanakena tu /
yal labdhaṃ tat pramāṇaṃ tu gaṇḍikāyā vini⟨rdi⟩śet // 29 //

ekayutā narasaṃkhy⟨ā⟩ // Q8 //

ekayutā narasaṃkhyā (dv)i⟨□ □ □ □ □ □⟩ .ī □ ca /
evaṃ tāvat kāryaṃ yāvat puruṣai samā bhavati // 14 //

eko rāśi dvidhā sthāpya rūpam ekā⟨...⟩ // Q9 //

kāmikaṃ śūnye vinyastaṃ tadā caiva krame guṇaṃ /
⟨prakṣiptena bhajed dṛśyaṃ prathamaṃ ca vinirdiśet⟩ // N10 //

kṛtvā rūpakṣayaṃ pārthaṃ dhāntaś⟨o⟩ guṇana⟨ṃ⟩ tataḥ /
pravṛttigu⟨ṇanenaiva jātaṃ śeṣaṃ⟩ vinirdiśet // 25 //

kṛtvā rūpakṣayaṃ pārthaṃ dhāntaśo ghātitaṃ tataḥ /
. . . . . // 26 //

kṣayaṃ saṃguṇya kanakās tadyutin bhājayet tataḥ /
saṃyutair eva kanakair ekaikasya kṣayo hi saḥ // 27 //

gatisyaiva viśeṣaṃ ca vibhaktaṃ pūrvagantunāḥ /
tenaiva kālaṃ bhavati ssa⟨mena gati⟩(k)⟨e⟩na tu // 15 //

gatisyaiva viśeṣaṃ tu vibhaktaṃ ⟨pūrvagantunā,
guṇam⟩ anena kāl⟨ena sa⟩(ma)gatī bhaviṣyati // N5 //

gavāṃ viśeṣa kartavyaṃ dhanaṃ caiva punaḥ ⟨ku⟩ruḥ /
⟨□ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ ⟩ // 51 //

⟨ . . . . ⟩ □ □ □ □ /
□ □ □ ⟨□ □ ⟩ guṇaye bhājay⟨e⟩ ekar⟨ā⟩(ś)⟨i⟩k⟨e⟩ // N19 //

⟨□ □ ⟩(gu)ṇe tu sadṛśaṃ ⟨. . . ⟩y⟨e⟩t ⟨.⟩ṛdyuta /
bhāgahāra □ □ ⟨□ □ □ □ ⟩ □ ⟨□ ⟩ // N4 //

guṇau ⟨□ □ □ □ □ □ □ □ ⟩ □ □ □ k. dhanaṃ /
guṇābhyāso rūpahīnaṃ labdhaṃ rūpaṃ ⟨□ □ □ □ ⟩ // N17 //

gu⟨ṇau pṛ⟩thagg rūpayutau yācanāyuktisaṃguṇāḥ /
guṇa(gh)nena guṇe(n)ai⟨va⟩ rūpahīnena bhājitau /
viparītayācanākṣiptau guṇasāmye rayaṃ vidhiḥ // 10 //

⟨□ □ □ □ □ □ □ □ □ □ □ ⟩ □ cchedasaṃguṇe /
(a)⟨□ □ □ □ □ □ □ ⟩ ūrdhayutaṃ hṛte phalaṃ // N3 //

tayor yoga viyogaṃ syā viyoga sati ⟨saṃgamaḥ⟩ // Q10 //

dinagamanam ādirahitaṃ ⟨yad⟩ dviguṇaṃ tac cottareṇa saṃyutaṃ /
pratinihita ātmaguṇaṃ j⟨ātaḥ⟩ kṣepasaṃjñako rāśiḥ /
aṣṭhottarasaṃguṇite kṣepasaṃjñako datvā /
mūla pratinihi(ta)⟨saṃyutaṃ ca⟩ dviguṇottarabhājitaṃ ⟨ca⟩ // 19 //

dinabhaktaviśeṣaṃ ca vi⟨□ □ □ □ □ □ □ ⟩ /
□ guṇa⟨ṃ k⟩ryate caiva kālam eṣāṃ vinirdiśet /
trairāśikavidhānena □ ⟨□ □ □ □ □ □ ⟩ṃ /
ś⟨u⟩l⟨k⟩ā dattaṃ ca pātavyaṃ sūkṣme dattaṃ ca tatsamaṃ // N2 //

deyaṃ vaṇikpiṇḍahataṃ śuddhaṃ ⟨pṛthak svapaṇyataḥ⟩ /
śeṣaparasparābhyāsaṃ svaśeṣeṇa vibhājayet /
⟨svapaṇyaguṇitaṃ yuktaṃ vaṇigbhaktaṃ samaṃ dhanaṃ⟩ // 13 //

dravyatulyaṃ vinikṣipya kuru prakṣepakaṃ tataḥ /
prakṣ⟨epayukti⟩ saṃsthāpya pṛthag vadha pra⟨kṣepakaiḥ⟩ // N13 //

dviguṇaṃ prabhavaṃ śuddhaṃ dviguṇān niyatāt tataḥ /
uttareṇa bhajec cheṣaṃ labdhaṃ rūpaṃ vinirdiśet // 21 //

⟨ .... niś⟩caya⟨ṃ⟩ /
yatra y⟨o⟩ga⟨ś⟩ ca ⟨ta⟩dbhāga⟨ṃ □ □ □ □ □ □ □ □ □ /
□ □ □ □ □ □ □ □ ta⟩dbhāgaṃ caiva kārayet /
kṣetravaipulyaḥ r. □ □ .t. □ .y. ⟨□ □ ⟩ □ ⟨□ □ ⟩ // N14 //

ma⟨dhyarā⟩śi guṇaye // Q11 //

pṛthak rūpaṃ vinikṣipya guṇābhyāso rūpahīnaṃ /
... // N16 //

yadṛcchāṃ vinyase śūnye tadā vargaṃ tu kārayet /
⟨prakṣiptena bhajed dṛśyaṃ prathamaṃ ca vinirdiśet⟩ // N9 //

yutahīnaṃ ca mekatvaṃ ⟨dvyūnadaladalaṃ kṛtiḥ⟩ /
hīne yutiṃ ca kartavyā ⟨yutahīne sa mūladaḥ⟩ // 50 //

rūpoṇā padasaṃkhyā tathottaraghnā dalitādisaṃyutā /
padaghnā ca kāryā yal labdhaṃ tad bhaved gaṇitākhyam // Q12 //

labdhaṃ dviguṇitaṃ kṛtvā ⟨dviguṇādyūnitaṃ tathā /
uttareṇa⟩ v⟨i⟩bhājitaṃ ⟨saikaṃ p⟩ra⟨ṣ⟩ṇ⟨ā⟩hva⟨yaḥ sa ca⟩ // 23 //

vastraśulkaṃ yad bhavati ta⟨dapa⟩hṛtavastrato /
trairāśikavidhānena śulka⟨m āna⟩ya tatvataḥ // 58 //

vikrayaṃ ca vibhaktavyaṃ guṇitaṃ kra⟨yar⟩āśivat /
kṛtvā rūpakṣayaṃ caiva vibhaktaṃ mūlaṃ ⟨ādi⟩sāt // 57 //

vikrayaṃ bhājaye caiva guṇayet krayapiṇḍatāṃ /
rūpoṇe mūla guṇaye labdha lābhaṃ ca prāpyate // 55 //

vikrayaṃ bhājaye caiva guṇayet krayapiṇḍavat /
vibhaktaṃ sa ca kartavyaṃ guṇaye miśrakaṃ budhaḥ /
yal labdhaṃ sā bhaven mū⟨laṃ⟩ yaś śeṣaṃ lābhapiṇḍatāṃ // 56 //

vi⟨kra⟩yena krayaṃ bhājyaṃ rūpahīnaṃ punar bhajet /
lābhe⟨na⟩ guṇaye tatra nīvī bhavati tatra ca // 54 //

śūnyasthāne rūpaṃ datvā tadanu yuktaṃ guṇita ⟨h⟩ī⟨naṃ vā⟩ /
.. // N12 //

śūnyam ekayutaṃ kṛtvā ..../
... // N8 //

⟨ha⟩yair vibhajya gantavyaṃ ⟨ekarathe 'śva⟩(sa)⟨ṃj⟩ñit⟨ai⟩ /
ekāśvagamana jñ⟨e⟩(ya)⟨ṃ⟩ yukt⟨ai⟩s sa⟨ṃg⟩u⟨ṇ⟩ya ⟨yojane⟩ // 22 //

APPENDIX B

Concordance of Rules and Examples

Notation for chapters and stanzas

Generally	W $m.n$ = Stanza n in Chapter m of W
For GSS	kal = kalāsavarṇa
	kṣe = kṣetra
	miś = miśraka
	par = parikarman
For PG and Tr	PG/Tr n = Rule n of PG/Tr
	PG/Tr Ex. n = Example n of PG/Tr

B.1 Concordance

Sūtras 1–8	Missing (unidentified)
Sūtra 9	No clue for restoration
Sūtra 10	GSS miś $251\frac{1}{2}$–$258\frac{1}{2}$ (cf. miś 233–237), BG 93 (ex.) and 136 (= 93)
Sūtra 11	PM A24–25
Sūtra 12	Missing (unidentified)
Sūtra 13	GSS miś 163–166, L 101 and 102, BG 98 (= L 102), PM A28, 29 (= GSS miś 164), and 30
Sūtra 14	Not understood
Sūtra 15	BM N5 and C3, BAB's exs. for AB 2.31, PG 65 and Ex. 81–82, GSS miś $326\frac{1}{2}$–$327\frac{1}{2}$, PM A3–4
Sūtra 16	BM 17 and 18, GSS miś $322\frac{1}{2}$–$323\frac{1}{2}$
Sūtra 17	BM 16 and 18
Sūtra 18	BM 16 and 17
Sūtra 19	None
Sūtra 20	BM 21 and 23, PG 96 and Ex. 111, GSS miś 319–320, PM A5–6
Sūtra 21	BM 20 and 23
Sūtra 22	GSS miś 157–158
Sūtra 23	BM 20 and 21, GSS miś 294–295, PM A9–10 and 31–32
Sūtra 24	PG 66 and Ex. 83, GSS miś 319 and $321\frac{1}{2}$
Sūtras 25–26	BSS 12.9, PG 39–40 and Exs. 18–21, Tr 24, GSS kal 113–121 and 126–131, MS 15.11–12, SS 13.10, GT pp.34–37, L 34–36

Sūtra 27	PG 52 and Exs. 61–62, Tr 36 and Exs. 63–64, GSS miś $169–171\frac{1}{2}$, MS 15.38, L 103–104
Sūtra 28	PG 54 and Ex. 65, GSS miś 175–179, L 106–107
Sūtra 29	PG 53 and Ex. 64, Tr 37 and Ex. 66, MS 15.39, L 103 and 105
Sūtras 30–49	Missing (unidentified)
Sūtra 50	BSS 18.73 and 84, GSS miś $275\frac{1}{2}–280\frac{1}{2}$
Sūtra 51	BAB's exs. for AB 2.30, BSS 18.43, SS 14.14, BG 89–91
Sūtra 52	BM C9
Sūtra 53	BM C2
Sūtra 54	GSS miś 167–168
Sūtra 55	None
Sūtra 56	None
Sūtra 57	None
Sūtra 58	None
Sūtra N1	BSS 12.16, PG 59 and Exs. 71–72, Tr 38, GSS miś $79\frac{1}{2}–86\frac{1}{2}$, SS 13.19, MS 15.36, L 94–95, PM A33–34
Sūtra N2	Not understood
Sūtra N3	PG 59 and Exs. 73–75, Tr 38 and Exs. 70–72, GSS miś $87\frac{1}{2}–91\frac{1}{2}$, MS 15.37–38, SS 13.19, L 98–99
Sūtra N4	PM A15–16 and B14
Sūtra N5	BM 15 (see BM 15 above for other works)
Sūtra N6	GSS miś $79\frac{1}{2}$, and $98\frac{1}{2}–101\frac{1}{2}$
Sūtra N7	None
Sūtras N8–N12	GSS kal 107–108, kṣe $112\frac{1}{2}–119\frac{1}{2}$, L 51–55
Sūtra N13	GSS miś $92\frac{1}{2}–94\frac{1}{2}$
Sūtra N14	BSS 12.44–45, GSS khāta $4–18\frac{1}{2}$, MS 15.105, SS 13.43, L 214–219
Sūtra N15	None
Sūtra N16	BSS 18.60–63, GSS miś 284–285, SS 14.20–21, BG 185–187
Sūtra N17	Not understood
Sūtra N18	AB 2.20, BSS 12.18, PG 87, Tr 41, GSS par 69–72 and kal 33–35, MS 15.50–51, SS 13.24, L 128–129
Sūtra N19	None
Sūtra C1	AB 2.28, BSS 18.14, PG 78 and Ex. 102, GSS miś 286–287, (cf. miś $111\frac{1}{2}$), MS 15.23, GT 83–85, SS 13.13, L 48–50
··· Ex. 1	BG 101
Sūtra C2	BM 53
Sūtra C3	AB 2.31 (cf. BAB's exs.)
Sūtra C4	BM 25–26 (see BM 25–26 above for other works)
Sūtra C5	GSS kṣe $175\frac{1}{2}$
Sūtra C6	GSS miś 222–225
Sūtra C7	PG 63–64 and Exs. 78–80, GSS miś $146\frac{1}{2}–153$, BG 138, PM A21
Sūtra C8	Not understood
Sūtra C9	BM 52
Sūtra C10	AB 2.26 (cf. BAB's exs.), BSS 12.10, PG 43–44 and Exs. 25–33, Tr 29 and Exs. 30–39, GSS trairāśika (one whole chapter), MS 15.24–25 and 30, GT 86–95, SS 13.14, L 73–76, PM A22–23

Sūtra Q1	BSS 12.9, PG 39 and Ex. 18–19, Tr 24, GSS kal 113–121, MS 15.11, GT pp.34–36, L 34–36
Sūtra Q2	None
Sūtra Q3	BSS 12.3, PG 33 and Ex. 10, Tr 20 and Ex. 9, GSS kal 2–7, MS 15.15, GT pp.19–20, SS 13.9, L 39–40
Sūtra Q4	BSS 12.4 and 60, PG 33 and Ex. 11, Tr 20 and Ex. 10, GSS kal 8–12, MS 15.15, GT pp.21–22, SS 13.10, L 41–42
Sūtra Q5	Not understood
Sūtra Q6	PG 41 and Ex. 22, Tr 26–27 and Ex. 22, GT pp.39–41, MS 15.18
Sūtra Q7	BM Q3 (see BM Q3 above for other works)
Sūtra Q8	Not undrestood
Sūtra Q9	BM Q12(?)
Sūtra Q10	PGT (pp.111, 132, and 133, cites the same verse), BAB (p.129) on AB 2.30, BSS 18.30–31, SS 14.3, BG 7–8
Sūtra Q11	None
Sūtra Q12	AB 2.19, BSS 12.17, PG 85 and Exs. 103–105, Tr 39 and Exs. 73–74, GSS par 61–68, kal 22–24, and miś 290–291, MS 15.47, SS 13.20, L 121–123

APPENDIX C

Numerical Data

C.1 Price

Thing	Price	Reference
a diamond	$\frac{55}{7700}$ *sateras/siddhārtha* $= 3\frac{3}{7}$ *sateras/tola*[2]	Sū[1] C10, Ex.28 (X 14)
a jewel	377 units[3]	Sū 11, Ex.1 (III 1–3)
a jewel	1095 units[4]	Sū 11, Ex.2 (III 3–4)
tin	$\frac{1}{100}$ *dramma* per piece(?)	Sū N19, Ex.1 (X 26)
?	400 *dīnāras/tola*	Sū C10, Ex.2 (X 2)
?	21 *dīnāras*	Sū N6, Ex.3 (II 4)
?	$5\frac{1}{3}$ *vajjaras/tola*[5]	Sū C10, Ex.3 (X 3)
?	35 *drammas/tola*	Sū C10, Ex.4 (X 4)
?	$3\frac{3}{80}$ *dhāṇas* of gold per *tola*	Sū C10, Ex.5 (X 5)
?	$3\frac{1}{48}$ *dhāṇas* of gold per *tola*	Sū C10, Ex.6 (X 5)
?	4 *rūpas* per piece(?)	Sū C10, Ex.44 (X 24)
garments	100 *paṇas* per piece	Sū 58, Ex.1 (VIII 10)
living beings		Sū C7, Ex.3 (VII 12)
a man	3 *maṇḍas*	
a girl	$\frac{3}{2}$ *maṇḍas*	
a *śūdra*[6]	$\frac{1}{2}$ *maṇḍa*	
meat(?)	1 unit/*ṭalla*	Sū N14, Ex.1 (V 5–6)
animals		Sū 13, Ex.1 (III 5)
an *aśva*[7]	42 units[8]	
		to be continued

1 Sū = Sūtra.
2 This conversion is meaningful, because in the example the price of a diamond is considered to be proportional to its weight. This is, however, not so in *Bṛhatsaṃhitā* 79.12–13.
3 No denomination given.
4 No denomination given.
5 6 *drammas* = 1 *vajjara*.
6 A man of the fourth cast.
7 A horse.
8 No denomination given.

Thing	Price	Reference
a *haya*[9]	28 units	
an *uṣṭra*[10]	24 units	
grains		Sū N3, Ex.1 (I 10–11)
taṇḍula[11]	$\frac{2}{9}$ *dramma/ḍhe*[12]	
mudga[13]	$\frac{2}{13}$ *dramma/ḍhe*	
grains		Sū 13, Ex.2 (III 6)
tā⟨mbūla⟩[14]	6 units[15]/*prastha*	
go⟨dhūma⟩[16]	3 units/*prastha*	
śā⟨li⟩[17]	2 units/*prastha*	
grains	(exchange ratios in barter)	Sū N1, Ex.5 (I 3)
taṇḍula[18] I	: *vrīhaka*[19] = 2:5	
taṇḍula II	: *vrīhaka* = 2:6	
taṇḍula III	: *vrīhaka* = 2:7	

C.2 Income and Expense

Who	Income (I) or Expense (E)	Reference (and Purpose of E)
a merchant	$I = \frac{9}{2}$ *vajjaras*/day	Sū C9, Ex.2 (IX 2–4)
	$E = \frac{64}{15}$ *vajjaras*/day	(for *pūjā* of Vāsudeva)
	$E = \frac{3}{2}$ *vajjaras*/day	(for entertaining brāhmaṇas)
	$E = \frac{5}{12}$ *vajjara*/day	(for materials of baskets?)
	$E = \frac{1}{3}$ *vajjara*/day	(for ?)
	$E = \frac{3}{16}$ *vajjara*/day	(for ?)
	$E = \frac{9}{20}$ *vajjara*/day	(for ?)
	$E = \frac{3}{8}$ *vajjara*/day	(for enjoying wine)
a man	$I = \frac{9}{8}$ *vajjaras*/day	Sū C9, Ex.1 (IX 1–2)
	$E = \frac{3}{2}$ *vajjaras*/day	(for Bha⟨vānī?⟩)
	$E = \frac{1}{32}$ *vajjara*/day	(for *pa⟨raloka?⟩*)
	$E = \frac{1}{64}$ *vajjara*/day	(for Śū⟨lin?⟩)
a man	$I = \frac{5}{2}$ *dīnāras*/day	Sū 52, Ex.1 (VIII 3–4)
	$E = 3$ *dīnāras*/day	(for ?)
a man	$I = \frac{7}{4}$ *drammas*/day	Sū C2, Ex.1 (I 9)
		to be continued

9 A horse.
10 A camel.
11 Unhusked rice.
12 The abbreviation, *ḍhe*, unidentified.
13 A kind of kidney-bean.
14 An areca nut.
15 No denomination given.
16 Wheat.
17 Rice.
18 Unhusked rice.
19 Rice.

Who	Income (I) or Expense (E)	Reference (and Purpose of E)
	$E = \frac{5}{6}$ *dramma*/day	(for ?)
a man	$I = 4$ *drammas*/day	Sū C2, Ex.2 (I 9)
a man	$E(?) = \frac{1}{2}$ *rūpa*/day	Sū Q11, Ex.1 (X 25)
two *bhṛtakas*[20]		Sū 53, Ex.1 (VIII 4–5)
1st person	$I = \frac{5}{3}$ *rūpakas*/day	
2nd person	$I = \frac{6}{5}$ *rūpakas*/day	
two *bhṛtakas*		Sū 21, Ex.1 (III 15)
1st person	$I_n = 2 + 3(n-1)$ *māṣakas*[21]	
2nd person	$I = 10$ *māṣakas*/day	
two men		Sū 20, Ex.1 (III 14)
1st person	$I_n = 3 + 4(n-1)$ *rūpakas*	
2nd person	$I = 7$ *rūpakas*/day	
two men		Sū 20, Ex.2 (III 14)
1st person	$I_n = 1 + 2(n-1)$ units	
2nd person	$I = 5$ units/day	
two men		Sū 18, Ex.1 (III 9)
1st person	$I_n = 5 + 6(n-1)$ units	
2nd person	$I_n = 10 + 3(n-1)$ units	

C.3 Donation and Stipend

Donor	Donée	Thing & Quantity	Reference
?	Śiva	gold, $\frac{3}{8}$ *rakti*/day	Sū C10, Ex.26 (X 13)
a king	8000 men	gold, $2312\frac{3}{8}$ *raktis*/day per person	Sū C10, Ex.38 (X 21)
?	?	gold(?), $\frac{291}{240}$ *raktis*/day	Sū C10, Ex.37 (X 20)
?	?	gold(?), $\frac{60881}{19200}$ *tolas*/day $\approx 3\frac{1}{5}$ *tolas*/day	Sū C10, Ex.1 (X 1–2)
?	?	gold(?), 1 *pāda*/day	Sū C10, Ex.14 (X 8)
?	108 *gurus*	$\frac{1}{26}$ *dīnāras* for one *guru*	Sū C10, Ex.12 (X 7)
a man	?	$\frac{1}{360000}$ *kākiṇī*/day	Sū C10, Ex.22 (X 11)
a king(?)	3 poets(?)		Sū N7, Ex.1 (IV 1)
	to 1st	3 *rūpas*/day	
	to 2nd	2 *rūpas*/day	
	to 3rd	$\frac{3}{5}$ *rūpa*/day	
a king	3 servants		Sū N1, Ex.4 (I 2)
	to 1st	30 *dīnāras*	
	to 2nd	20 *dīnāras*	

to be continued

20 Hired servants.
21 I_n = the income for the n-th day.

Donor	Donée	Thing & Quantity	Reference
	to 3rd	15 *dīnāras*	
a king	2 princes		Sū 53, Ex.2 (VIII 5–6)
	to 1st	$\frac{13}{6}$ *dīnāras*/day	
	to 2nd	$\frac{3}{2}$ *dīnāras*/day	
?	3 men		Sū N7, Ex.2 (IV 2–3)
	to 1st	$\frac{5}{3}$ *dīnāras*/day	
	to 2nd	$\frac{21}{8}$ *dīnāras*/day	
	to 3rd	$\frac{18}{5}$ *dīnāras*/day	
a king(?)	70 men	$\frac{4}{21}$ *dramma*/day per person	Sū C10, Ex.35 (X 18–19)
a king(?)	70 watchmen	$\frac{1}{5}$ *dramma*/day per person	Sū C10, Ex.36 (X 19)

C.4 Tax

Kind of Tax	Taxed	Rate	Reference
sales tax	clothes	$\frac{1}{20}$ of the value	Sū 58, Ex.1 (VIII 10)
customs tax	saffron	$\frac{1}{4}$ of the quantity	Sū 25, Ex.6 (III 24–25)
toll taxes	a traveling merchant	1 to 5 units	Sū C1, Ex.1 (I 7–8)

C.5 Speed

Thing	Speed	Reference
a snake	$\frac{32}{63}$ *aṅgula*/day	Sū C10, Ex.9 (X 6)
a snake(?)	$\frac{1}{2}$ *aṅgula*/day	Sū C10, Ex.18 (X 10)
a worm	$\frac{1}{2}$ *aṅgula*/day	Sū C10, Ex.10 (X 6)
a worm	$\frac{1}{2}$ *aṅgula*/day	Sū C10, Ex.23 (X 12)
?	64 *aṅgulas*/year	Sū C10, Ex.8 (X 6)
a climber of Meru	10 *yojanas*/day	Sū C10, Ex.15 (X 8)
a ship	$\frac{3}{10}$ *yojana*/day	Sū C10, Ex.24 (X 12)
the sun	$5 \cdot 10^8$ *yojanas*/day	Sū C10, Exs.29 and 30 (X 15)
Jupiter	5 *liptās*/day	Sū C10, Ex.31 (X 16)
Saturn	2 *liptās*/day	Sū C10, Ex.32 (X 16)
a falling garment	293 *yojanas*/day	Sū C10, Ex.19 (X 10)
two travelers		Sū C3, Ex.1 (I 18)
1st person	$\frac{3}{16}$ *yojana*/day	
2nd person	$\frac{1}{4}$ *yojana*/day	
two travelers		Sū N5, Ex.1 (I 17)
1st person	$\frac{3}{2}$ *yojanas*/day	
2nd person	2 *yojanas*/day	
two travelers		Sū 24, Ex.1 (III 18)
1st person	6 *yojanas*/day	
		to be continued

Thing	Speed	Reference
2nd person	1 *yojana*/day	
two travelers		Sū 15, Ex.2 (III 7)
1st person	5 *yojanas*/day	
2nd person	9 *yojanas*/day	
two travelers		Sū 15, Ex.3 (III 7)
1st person	18 *yojanas*/day	
2nd person	25 *yojanas*/day	
two travelers		Sū 19, Ex.1 (III 10–11)
1st person	5 *yojanas*/day	
2nd person	$3+4(n-1)$ *yojanas* for the n-th day	
two travelers		Sū 19, Ex.2 (III 11–13)
1st person	7 *yojanas*/day	
2nd person	$5+3(n-1)$ *yojanas* for the n-th day	
two travelers		Sū 17, Ex.1 (III 8)
1st person	$2+3(n-1)$ *yojanas* for the n-th day	
2nd person	$3+2(n-1)$ *yojanas* for the n-th day	

C.6 Height

Thing	Height	Reference
Mount Meru	84,000 *yojanas*	Sū C10, Ex.15 (X 8)
Brahmaloka (its ceiling)	$1,465 \cdot 10^5$ *yojanas*	Sū C10, Ex.19 (X 10)

C.7 Military Affairs

Data	Reference
components of armies	Sū C10, Ex.42 (X 22–23)
1 *patti* or *śiras* = 1 chariot + 1 elephant + 3 horses + 5 foot soldiers	
1 *senāmukha* = 3 *pattis*	
1 *gulma* = 3 *senāmukhas*	
1 *gaṇa* = 3 *gulmas*	
1 *vāhinī* = 3 *gaṇas*	
1 *pṛtanā* = 3 *vāhinīs*	
1 *camū* = 3 *pṛtanās*	
1 *anīkinī* = 3 *camūs*	

to be continued

Data	Reference
1 *akṣauhiṇī* = 10 *anīkinīs*	
number of arrows shot in one *krośa* = 60	Sū C10, Ex.27 (X 14)
number of arrows shot against one *patti* = 15	Sū C10, Ex.40 (X 22)
number of arrows shot against one *patti* = 30	Sū C10, Ex.41 (X 22)
three stables	Sū N6, Ex.4 (II 6)
1st stable contains 180 cows	
2nd stable contains 180 horses	
3rd stable contains 180 she-buffaloes	
a *vaṃsura* (troop?) contains 120 horses	Sū N6, Ex.9 (II 9)
a chariot is pulled by 10 horses at a time	Sū 22, Ex.1 (III 16)

C.8 Others

Data	Reference
number of hairs on skin = 3600 per square *aṅgula*	Sū C10, Ex.13 (X 7)
weight of a lump of salt = 1075 *palas*	Sū C10, Ex.21 (X 11)
number of turning-backs of a falling garment = $\frac{10}{11}$ per *dhanus*	Sū C10, Ex.16 (X 9)
11 birds eat 1 *prasṛti* of grain	Sū C10, Ex.25 (X 13)

APPENDIX D

Terms for the Fundamental Operations*

D.1 Addition

$\sqrt{}$*kal* *saṃkalita* (summation)

$\sqrt{}$*kṣip* *kṣipta* (added, increased by), *kṣepa* (addendum), *prakṣipta* (added), *nikṣipya/vinikṣipya* (having added).

$\sqrt{}$*ci* *caya* (the common increase of a progression).

$\sqrt{}$*dā* *dīyate* (is added), *dadyā⟨t⟩* (one should add), *dat⟨t⟩vā* (having added).

$\sqrt{}$*piṇḍ* *piṇḍa* (sum).

$\sqrt{}$*miśr* *vimiśṛta* (= *vimiśrita*, increased by), *miśra/miśraka* (sum).

$\sqrt{}$*yu* *yuta/saṃyuta* (increased by, summed up), *yuti/saṃyuti* (sum).

$\sqrt{}$*yuj* *yojayet* (one should add), *yukta/yogīkṛta* (increased by, summed up), *yojya* (to be added), *yukti/yoga/saṃyoga* (sum).

$\sqrt{}$*vṛdh* *vṛddhi* (increase), *udvardha* (increase), *pravardhita* (increased by).

Others *adhika/uttara/sa/saha/sahita* (excess, plus, increased by), *eka/ekat(t)ra/ekatva/sarvasva* (sum total).

D.2 Subtraction

$\sqrt{}$*ujjh* *ujjhita/projjhita* (subtracted), *projjhya* (having subtracted).

$\sqrt{}$*ūn* *ūna/ūnaka/ūnita* (minus, decreased by).

$\sqrt{}$*kṣi* *kṣaya* (loss, negative quantity).

$\sqrt{}$*pat* *pāta* (subtraction), *pātita* (subtracted), *pātayitvā* (having subtracted), *pātya* (to be subtracted).

$\sqrt{}$*yuj* *viyoga* (difference).

$\sqrt{}$*rah* *rahita* (decreased by).

$\sqrt{}$*vṛj* *varjita* (decreased by), *varjayet* (one should diminish).

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* See Index for references.

√*śiṣ* *śeṣa/viśeṣa* (difference, remainder of subtraction).

√*śudh* *śuddhi* (subtraction, difference), *śuddha/saṃśuddha/śodhita* (subtracted), *viśodhayet/śodhayet* (one should subtract), *viśoddhya/śodhayitvā* (having subtracted), *śoddhya/saṃśoddhya/śodhanīya* (to be subtracted).

√*hā* *hīyate* (is decreased), *hitvā* (having decreased), *hīna* (decreased), *vihīyamāna* (being decreased).

Others *vi-* (less).

D.3 Multiplication

√*as* *abhyāsa* (multiplication, product), *abhyasta* (multipied by, product).

√*guṇ* *guṇana/saṃguṇana* (multiplication), *guṇākāra* (multiplier), *guṇa* (multiplied by, multiplication, product, multiplier), *guṇita/saṃguṇa/ saṃguṇita* (multiplied by), *guṇitavya* (to be multiplied), *guṇaye⟨t⟩/saṃguṇaye⟨t⟩* (one should multiply), *saṃguṇya* (having multiplied), *una* (= *guṇa*, multiplied by).

√*vadh* *vadha* (impv., multiply).

√*vṛj* *varga* (multiplication, see Sec. 6.8 of Introduction).

√*han* *hata/samāhata/ghātita/ghna* (multiplied by), *ghana* (= *ghna*).

Others *cheda* in *adhaccheda* and *ūrdhaccheda* seems to signify a multiplier (see Sec. 6.1 of Introduction). *dāpaye⟨t⟩* used in Sūtra Q6 (X 17) is forced to mean multiplication (see Commentary). *anvaya* used in '*śatam ekaṃ dvayānvayaṃ*' = 200 (IV 4) signifies the multiplication, 100×2.

D.4 Division

√*chid* *cheda* (division, divisor), *chedita* (divided by).

√*dal* *dala* (half), *dalita* (halved).

√*bhaj* *bhakta/bhajita/bhājita/vibhakta/vibhājita/saṃbhakta* (divided by), *bhaktavya/bhājya/vibhaktavya* (to be divided), *bhaktvā/vibhajya* (having divided), *bhajet/bhājayet/vibhajet/vibhājayet* (one should divide), *bhāga* (division), *bhāgahāra* (divisor, division). The verb *bhaj* often means to make the reciprocal of a number.

√*bhid* *bhedaṃ dat⟨t⟩vā* (having divided).

√*labh* *labdha* (quotient).

√*vṛt* *parivartana* (reciprocal), *apavarta* (impv., reduce the fraction to smaller terms), *vartita* (reduced), *vartya* (to be reduced, see Sec. 6.8 of Introduction).

√*hṛ* *hara* (divisor), *hartya* (to be divided), *hṛta* (divided), *bhāgahāra* (divisor, division), *hṛti* (division), *bhāgaṃ hṛtvā* (having divided).

Others *ardha* (half), *pada/pāda* (a quarter).

D.5 Square

$\sqrt{}$*kṛ* *kṛti/karaṇi* (square, see Sec. 6.2 of Introduction), *akṛti* (a non-square number).

$\sqrt{}$*vṛj* *varga* (square), *vargita* (squared).

Others *yāva* (square, see Sec. 6.7 of Introduction).

D.6 Square Root

$\sqrt{}$*kṛ* *karaṇī* (square root of a non-square number, see Sec. 6.2 of Introduction).

$\sqrt{}$*mūl* *mūla* (square root).

APPENDIX E

Proper Names

E.1 Epical/Mythological Names

Arjuna (X 14). The third Pāṇḍava prince, son of Kuntī by Indra.

Kīcakanighna (? X 22) = Bhīma. The second Pāṇḍava prince, son of Kuntī by Vāyu.

Pāṃḍu (X 16). The son of Ambālikā by Vyāsa. Father of the Pāṇḍavas.

Pārtha (X 22). A metronymic of the Pāṇḍavas, especially of Arjuna.

Bha⟨vānī?⟩ (IX 1) = Pārvatī, wife of Śiva.

Mahoragāḥ (X 15). The great serpents, a class of semi-divine beings.

Yudhiṣṭhira (X 16). The first Pāṇḍava prince, son of Kuntī by Yama.

Rāvaṇa (X 9). The chief of the Rākṣasas, king of Laṅkā.

Rbhāṇu (X 15) = Bhānu, the sun god.

Vāsudeva (IX 2) = Kṛṣṇa.

Vidyādhara (X 15). A class of semi-divine beings.

Śatrudamana (X 23). Said to be a prince. Not identified. Cf. Śatrughna, twin brother of Lakṣmaṇa, being a son of Sumitrā by King Daśaratha.

Śarva (X 13) = Śiva.

Śiva (X 27). A god.

Śūlin (X 13, IX 1?) = Śiva.

Siddhāḥ (X 15). A class of semi-divine beings.

Sītā (X 9). The daughter of Janaka, wife of Rāma.

Surāḥ (X 7, 15). Gods.

Hehaya (X 22) = Haihaya, Arjuna Kārtavīrya.

E.2 Cosmographic Names

Brahmaloka (X 10). The world of Brahman. The seventh, highest world above the earth. It is also called Satyaloka (the world of truth).

Sumeru (X 8). Mount Meru, supposed to be at the center of the central continent called Jambūdvīpa.

E.3 Others

Chajaka (X 27). Father of the 'writer' of the Bakhshālī Manucript (or at least part of it).

⟨Mā?⟩rtikāvati (X 27). The fragmentary word, *-rtikāvati*, that occurs in the colophon to Section X, may be restored Mārtikāvati = Mṛttikāvatī, the name of a place (see Sec. 14.2 of Introduction).

Vasiṣṭha (X 27). Father of Hasika.

Hasika (X 27). Son of Vasiṣṭha. The Bakhshālī Manuscript (or at least part of it) was 'written' (*likhita*) for him.

APPENDIX F

Addressees in Examples*

F.1 List of Addressees

gaṇaka. A calculator.

gaṇakottama. Best of calculators.

tatvajña. A truth-knower, a *brāhmaṇa* in particular.

dvija. A twice-born man.

dvijottama. Best of twice-born men.

dharmajña. A law-knower, or a righteous man.

paṇḍita. A learned man, scholar.

prājña. A wise man.

budha. An intelligent man.

matimat (in the commentary). An intelligent man.

mahātmavat. A high-minded man.

yati. An ascetic.

sakhi. A friend (male).

sundarī. A lovely lady.

F.2 Remarks

Most of the above addresees are commonly used in other mathematical works also. In out text, *gaṇakottama* and *paṇḍita* occur most frequently. The addressees, *dharmajña* and *yati*, are rather unusual in mathematical texts.

Female addressees, like *sundarī* in our text, occur also in the *Līlāvatī* (13, 17, 50, 55, 67, 69, and 71). Virahāṅka's *Vṛttajātisamuccaya*, a Prakrit work on prosody composed some time between the sixth and the eighth centuries, addresses some of its metrical rules to a lady or ladies. The word *sundarī* is one of those used in the vocative case (see *Vṛttajātisamuccaya* 6.48 and 51). Ratnaśekhara's

* See Index for references.

Ācārapradīpa (AD 1460), a Jaina philosophical work, contains four arithmetical problems about fractions (*kalāsavarṇa*), which are addressed to two maidens, and one of the problems contains the vocative feminine *kanye*. See Kāpadīā 1936/37. Ṛṣabha the first Tīrthaṅkara, a legendary figure in Jainism, is said to have taught arithmetic to his daughter, Sundarī by name. See Kāpadīā 1937, vii.

APPENDIX G

Patan Manuscript HJJM 8894

G.1 Introduction

A small manuscript preserved in the library of a Jaina institute of Patan is edited here because it contains an example (A23) whose data are strikingly similar to those of Ex. 9 for Sūtra C10 of the *Bakhshālī Manuscript.* This manuscript does not claim any originality. In fact, it is a compilation of rules and examples taken from different sources. In this sense also, the manuscript resembles the *Bakhshālī Manuscript.*

G.1.1 Description of the Manuscript

Location: Shree Hemacandracharya Jain Jnan Mandir, Patan (North Gujarat), Ms. No. 8894.

Although the manuscript number, 8894, is written both on the first and the last pages (fol. 1a and fol. 4b), the physical appearance, script, and the style of exposition indicate that the present codex consists of two manuscripts containing different works, which I designate A and B. Manuscript A consists of rules, examples, and a commentary on them. The commentary explains the rules in Sanskrit, and gives working processes of the solutions to the examples. Manuscript B, on the other hand, mainly consists of problems for fractions with their answers. It contains only four rules (B6–B9), three of which are concerned with the sum of the natural series.

Manuscript A: HJJM 8894, fols. 1–4a

Title: Unknown.

Subject: Mathematics.

Author: Anonymous.

Date: Later than Ṭhakkura Pherū (fl. ca. AD 1315), who is mentioned by name in the manuscript.

Languages: Sanskrit for the prose portions, and Sanskrit and Prakrit for the verses.

Script: Devanāgarī.

Size and materials: 23.5 × 10.3 cm, paper.

Number of lines of writing on a page: 17 or 18.

Number of akṣaras in a line: 40 to 50.

Extent: Apparently incomplete.

Each folio has the folio-number on its reverse side except for fol. 4, which has been given the number on its obverse side. This fact probably signifies that the reverse of fol. 4 was blank. The last, 17th line of writing of fol. 4a reads:

> ... *evaṃ stambhoddeśakajātiḥ // cha //*
>
> ... Thus is ⟨completed⟩ the class of pillar-problems.

and more than half of that line is left blank. Each folio, inclusive of fol. 4, has a hole for a chord at its center, its diameter being about 1 cm.

Manuscript B: HJJM 8894, fol. 4b

Title: Unknown.

Subject: Mathematics.

Author: Anonymous.

Date: Unknown.

Languages: Sanskrit and Prakrit.

Script: Devanāgarī with the *pṛṣṭhamātrā 'e'*.

Size and materials: 24.5 × 11.0 cm, paper.

Number of lines of writing on a page: 18.

Number of akṣaras in a line: About 55.

Extent: Incomplete. Ends abruptly in the middle of the 16th stanza.

Explanatory notes with numerical figures are written both in the left and the right margins, probably by the same hand. Although this page immediately follows fol. 4a on the photostat copy I have aquired, it does not exhibit a hole for a chord. It is also noticed that the form of the numerical figure 4 for the folio number, that is written in margin, is different from that that occurs in the manuscript itself, but both may have been produced by the same hand.

G.1.2 Three Sections of Manuscript A

Manuscript A can be divided into three sections according to the numbering of the stanzas.

Section I (A1–A18). The stanzas, numbered from 1 to 14, are taken exclusively from the *Gaṇitasāra* of Ṭhakkura Pherū (fl. AD 1315), who is mentioned by name at the end of this section, and examples A8, A12, A14, and A16 are prose rendering of Pherū's verses.

Section II (A19–A42). The stanzas of this section are not numbered, as in Manuscript B. It begins with a rule without any introductory remark, and ends with an incomplete Āryā stanza, which reads thus:

Based on the instructions of his own *guru*, the *gaṇitavidhi* (Rule of mathematics), which produces admiration among mathematicians, ⟨lacuna?⟩ at the glorious fort, Campaka-druga.

It is not certain whether the word *gaṇitavidhi* is the name of the work preserved in Manuscript A itself, or it refers to the work from which some of the rules and examples of this section were taken, or the word, meaning 'a computational rule,' simply refers to the last rule of this section, which might have been personally taught to the author by his *guru*.

I owe to Prof. David Pingree the information that Campakadruga is the name of a fort at Campakanagara (= Cāmpāner), an important town about 25 miles east of Baroda, founded in ca. AD 775 and, until the Muslim invasions, ruled by a local feudatory of the rulers of Patan.

Section III (A43–A54). The stanzas numbered from 1 to 10, together with two unnumbered stanzas, of this section have been taken exclusively from Śrīdhara's *Pāṭīgaṇita* and *Triśatikā*, or from his larger work, the *Navaśatī*, that is now lost, although none of these works is mentioned by name. The *Navaśatī* is not an improbable source, because PM A49 gives the same formula as PG 46cd and Tr 32cd, but its wording is slightly different. Moreover, PM A51, which is nothing but PG Ex. 51, does not occur in the Tr, while PM A52, which is Tr 27cd, does not occur in the PG.

G.1.3 Sources

In the following list, the abbreviations, deś, pra, and miś, designate respectively the chapters (or sections) called *deśavastrayantra*, *prakīrṇaka*, and *miśraka* of the GS and the GSS.

PM	Topics	Sources
A 1	Shadow problem	GS 3.101
2	Ex.	GS 3.102
3	Two runners	GS 4. deś 13
4	Ex.	GS 4. deś 14
5	Ex. for A6	GS 4. deś 15
6	Two walking camels	GS 4. deś 16 = pra 9
7	Flowers	GS 4. pra 1
8[1]	Ex.	GS 4. pra 2
9	Mangoes	GS 4. pra 3
10	Ex.	GS 4. pra 4
11	Eating *Sola*	GS 4. pra 5
12[2]	Ex.	GS 4. pra 6
13	Clothes	GS 4. pra 7
14[3]	Ex.	GS 4. pra 8
15	Cows	GS 4. pra 17
16[4]	Ex.	GS 4. pra 18
		to be continued

1 Rendered into prose.
2 Rendered into prose.
3 Rendered into prose.
4 Rendered into prose.

PM	Topics	Sources (*continued*)
17	Think two numbers	GS 4. pra 14
18	Think a number	GS 4. pra 13
19	Equal properties	
20	Ex.	
21	Ex. (Hundred creatures)	PG Ex. 78–79[5]
22	Going forward and backward	PG 44ab
23	Ex.	cf. BM Sūtra C10, Ex. 9
24	Price of a jewel	cf. BM Sūtra 11
25	Ex.	
26	Properties	GSS miś 159
27[6]	Ex.	GSS miś 160–162
28	Equal properties	GSS miś 163
29[7]	Ex. 1	GSS miś 164
30	Ex. 2	
31	Monkeys	cf. A9
32	Ex.	
33	Reciprocals	GS 2.3
34	Ex. 1 (Gift of a king)	GS 2.4
A36	Cistern problem	
37	Ex.	
38	Cistern problem	L 96
39	Ex. 1	L 97
40	Ex. 2	GS 2.5
41	Ex. (Multi-fractions)	= B3
42	Multiplication	
43	Ex. (Rule of seven)	PG Ex. 45 = Tr Ex. 51
44	Ex. (Rule of nine)	PG Ex. 46 = Tr Ex. 52
45	Ex. (Rule of nine)	PG Ex. 47 = Tr Ex. 53
46	Barter	PG 46ab = Tr 32ab
47	Ex. 1	PG Ex. 48 = Tr Ex. 54
48	Ex. 2	PG Ex. 49 = Tr Ex. 55
49	Selling creatures	PG 46cd = Tr 32 cd
50	Ex. 1	PG Ex. 50 = Tr Ex. 56
51	Ex. 2	PG Ex. 51
52	Pillar problem	Tr 27cd
53	Ex. 1	Tr Ex. 23
54[8]	Ex. 2	
B 1	Ex. (Men)	
		to be continued

5 = GSS miś 152–153 = BG 138. Cf. *Gaṇitakaumudī*, part 1, p.93.
6 Rendered into prose.
7 Rendered into prose.
8 A variation of A53.

PM	Topics	Sources (*continued*)
2	Ex. (Perls)	Tr Ex. 26
3	Ex. (Elephants)	= A41
4	Ex. (Gold)	
5	Ex. (Elephants)	Tr Ex. 27
6[9]	Natural series	cf. GS 1.18
7	Natural series	PG 14 = Tr 1
8	Natural series	cf. GS 1.18
9	Think a number	cf. A18
10	Ex. (Pillar problem)	Tr Ex. 25
11[10]	Ex. (Pillar problem)	
12	Ex. (Cistern problem)	cf. A35
13	Ex. (Bees)	Tr Ex. 28 = GSS pra 6
14	Ex. (Cows)	
15	?	
16	?	

G.1.4 Apparatus

The conventional use of the *anusvāra* for the nasals and the irregular *sandhis* found in the Sanskrit portion have been silently corrected in the present edition. Repetition of the same word is, in Manuscript A, often expressed by the numerical figure '2': e.g., *vāra* 2 (A7) for *vāra vāra* (= *vāraṃ vāraṃ*), *pṛthak* 2 (A 25, A34) for *pṛthak pṛthak*, and *bhāga* 2 *vihī* (A33) for *bhāgabhāgavihī* (= *-vidhiḥ*). These have been restored freely in this edition. Numbers are often expressed by numerical figures even when they occur as a member of a compound. See, for example, ... *cchāyā 18-aṅgulā* in A2. In such cases, I have supplied a hyphen. Other corrections are noted either in the apparatus, or in the text itself with the following symbols.

- (A): A should be deleted.
- ⟨A⟩: A has been supplied by me.

A pair of quotation-marks in the text indicate part of a stanza. For easy references, I have given serial numbers to all rules and examples, versified or not, in each of Manuscripts A and B. Important varinats in the sources of our text are also mentioned in the footnotes.

G.2 Patan Manuscript HJJM 8894

G.2.1 Manuscript A

Section I

⟨A1⟩ chāyāvyavahāre karaṇasūtram āryā //

9 Exactly the same stanza is cited by Abhayadeva Sūri on *Sthānāṅga* Sūtra 747. GS 1.18 gives the same rule in a different wording.

10 A variation of A53.

thaṃbhāibhittichāyā daṃḍe[11] miṇavi guṇa(ha) daṃḍamāṇena /
tassa va daṃḍacchāyā harij⟨j⟩a bhāyaṃ phaleṇudayaṃ // 1

stambhādibhitticchāyā daṇḍena mapitvā daṇḍena guṇyā / tasyaiva daṇḍasya cchāyayā bhāge yat phalaṃ tad udayamānaṃ ⟨//⟩ yathā /

⟨A2⟩

caüvīsaṃguladaṇḍe chāyā thaṃbhassa tinnidaṃḍasavā[12] /
daṃḍassa ya[13] addhārasa aṃgula kiṃ thaṃbhaüccattaṃ // 2

caturviṃśatyaṅgulena daṇḍamānena stambhasya cchāyā sapādadaṇḍatrayamitā daṇḍasya cchāyā ⟨//⟩ 18-aṅgulā ⟨/⟩ kiṃ sta⟨m⟩bhodayamānam ⟨//⟩ stambhacchāyāṅgulīkṛtā ⟨//⟩ 78 ⟨/⟩ daṇḍāṅgulaiś caturviṃśatyā guṇitā ⟨/⟩ 1872 ⟨/⟩ daṇḍacchāyā-18⟨/⟩-aṅgulair bhakte labdhaṃ ⟨//⟩ 104 stambhodayaḥ ⟨//⟩

⟨A3⟩ dhāvakagatau karaṇasūtram ⟨/⟩

lahugaï diṇasaṃkhaguṇaṃ lahudīhagaïssa aṃtare bhāgaṃ /
labdhadiṇehiṃ milaṃti ⟨/⟩ appagaī bahugaī do vi / 3 //

⟨A4⟩ udā° /

caüjoaṇīu pacchā navamadiṇe sattajoaṇī calíu ⟨/⟩
tassa va hoḍaṇa heū milei so kahaï[14] *divasehiṃ* // 4

caturyojanagāt paścān navamadine saptayojanīgantā calitaḥ kiyaddinair milati ⟨/⟩ nyāsaḥ / 4 / 9 / 7 / caturbhir nava guṇyante ⟨//⟩ 36 ⟨//⟩ caturṇ⟨ṇ⟩āṃ saptānāṃ cāntareṇa bhāge / 12 / dvādaśabhir dinair militaḥ ⟨//⟩

⟨A5⟩

paṃcāi duvaḍḍaṃto joaṇa divaseṇa callae karaho ⟨/⟩
joaṇacaüdasakarahī kittiadivasehi⟨ṃ⟩ sā milaï / 5 /

nyāsaḥ / 5 / 2 / 14[15] ⟨/⟩

⟨A6⟩

āimajjhaṃtarāsī[16] ⟨/⟩ aṃtāo[17] āihīṇa majjheṇa[18] ⟨/⟩
bhāyaṃ labdhaṃ viuṇaṃ egajuaṃ karaha diṇamānaṃ // 6

labdhāṅka-10⟨/⟩-dinair milati //

⟨A7⟩ kusumānayane karaṇasūtram //

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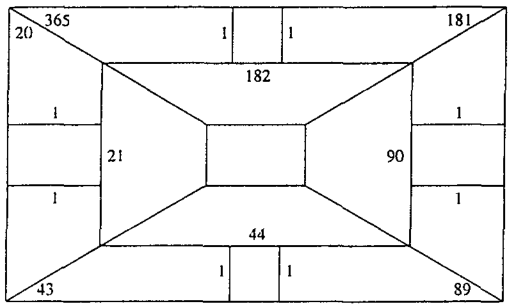
11 'da' before 'daṃḍe' deleted.
12 tinti-.
13 daṃḍasavā in GS.
14 kaïya in GS.
15 21 / 4.
16 āimabbhaṃtarāsī.
17 aṃtāu.
18 mabbheṇa.

dugunāduguṇa ji uvvaraïṃ[19] vāra vāra tihiṃ jutta /
jaï ko kusuma na uvvaraïṃ[20] (/) tā dhuri tinni[21] niruttā // 7 /

śeṣapuṣpāṇi dvārasaṃkhyaṃ dviguṇīkṛtya tribhir yuktāni sarvapuṣpasaṃkhyā / puṣpaśeṣo yatra na syāt tatrādau puṣpatrayaṃ prakalpya prāgvat prakalpyā / yathā

⟨A8⟩ kaścid dhārmikaś caturdvāracaitye pratidvāraṃ praveśanirgamayor yakṣasyaikaikaṃ kusumaṃ dat⟨t⟩vā śeṣa(/)kusumār(d)dhena devārcaṃ vidhāya śeṣāṇi viṃśa(ṃ)ti⟨ṃ⟩ darśayati ⟨/⟩ tatra kā sarvapuṣpasaṃkhyā ⟨//⟩

nyāsaḥ / śeṣapuṣpa / 20 / dviguṇa / 40 / tribhir yukte // 43 / dviguṇe / 86 / triyukte / 89 / dviguṇe / 178 ⟨/⟩ tri⟨yukte⟩ / 181 / dviguṇe 362 triyukte / 365 / evaṃ sarvakusumasaṃkhyā //

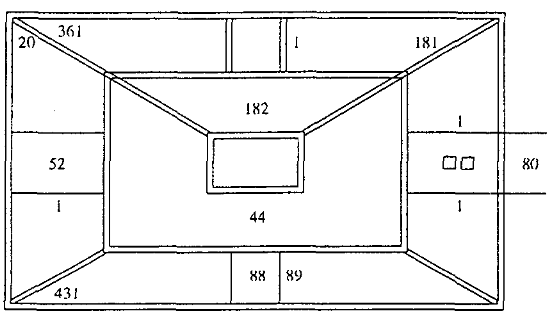


[22]

⟨A9⟩ āmr⟨ā⟩nayane karaṇasūtram //
je pattā te aṃsi guṇijjaïṃ āihīṇa kari vuḍḍhi harijjaï /
laddhā biuṇarūvasaṃjuttā (/) paṃḍia te ja⟨fol. 1b⟩ṇa gayā (/) niruttā ⟨/⟩
seḍhīsaṃkalie phalasaṃkhā laddhavihatte (/) hui jaṇasaṃkhā[23] / 8 /
yathā

⟨A10⟩
aṃsa aḍḍhama kaṭakamajjāu
gaya aṃbatoḍaṇavaṇihiṃ (/) bhakkhaṇattha āpasa[24] rāyaṇa /
caürādiṃ ya vuḍḍhi chahaeṇa parihiṃ savvehiṃ āṇia /
jaṃ kaṭaka tthaü laddha tahiṃ vīsa vīsa (/) savvehiṃ /
kaï jaṇa gaya kittaü kaṭaka kaï aṃbāṇi (aṃ) tehiṃ / 9 /

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19 uvvarahi in GS.
20 uccaraï.
21 tinti.
22


23 phalasaṃkhyā in GS.
24 āesi in GS.

nyāsaḥ / aṣṭamāṃśaḥ[25] 8 / ādiḥ 4 / vṛddhiḥ 6 / prāptaphala⟨m⟩ 20 / phalam aṃśaguṇaṃ

8
20

jātaṃ / 160 / ādi-4-hīne 156 / vṛddhyā ṣaṭkena bhāge // 26 / dviguṇe 52 / rūpayute 53 / iyaṃ sainyāṣṭamāṃśajanasaṃkhyā / atha śreḍhīsaṅkalite nyāsaḥ / 4 / 6 / 53 / gaṇite[26] labdham āmramānaṃ 8480 ⟨/⟩ asya viṃśāṃśaḥ / 424 / kaṭakajanasaṃkhyā // cha //

⟨A11⟩

guṇaka thapya vi kamiṇa egād
avaruppara[27] guṇi vi guṇiṃ vāra vāra ikkikka dijjaï
varasolāṃ je havaïṃ savvi tei paṭhama ha bhaṇijjaïṃ /
te vi aṃka rūvā ha viṇu puvva paraïṃguṇi aṃti[28] /
huiṃ ji ti bhakhaïṃ savvajaṇa paṃḍia ia pabhaṇaṃti // 10 /

krameṇaikādayo guṇakāḥ sthāpyante / pratyekaṃ pūrvapūrveṇa saṃguṇya rūpayutaṃ kāryam / eṣā janopabhoktavyasolasaṃkhyā[29] / ete 'pi gu⟨ṇaka⟩sthāpitāṅkāḥ pratyekaṃ pūrvapūrveṇa guṇyā bhakṣitasaṃkhyā bhavati // yathā //

⟨A12⟩ ke 'pi pañca jāmātaraḥ śvaśrūgṛhe gatāḥ / teṣv ādyasya śvaśrvā varasolakāni dattāni tadbhakṣitaśeṣāṇi dviguṇīkṛtya dvitīyasya tadbhakṣitaśeṣāṇi triguṇīkṛtya tṛtīyasya tadbhakṣitaśeṣāṇi caturguṇīkṛtya caturthasya tadbhakṣitaśeṣāṇi pañcaguṇīkṛtya pañcamasya ⟨/⟩ tena sarvāṇy api bhakṣitā⟨ni⟩ / t⟨ā⟩ni samāni (/) jātāni //

nyāsaḥ

1
2
3
4
5

pūrvapūrveṇa guṇanam ⟨/⟩ ekena dvike guṇite ekayute / 3 / tena trikena trike guṇite ekayute / 10 / caturguṇe saike ca / 41 / pañcaguṇe saike ca 206 ⟨/⟩ iyanti prathamajāmātur dattāni ⟨//⟩ punaḥ pūrvaguṇakānāṃ pūrvapūrvaguṇanam ⟨/⟩ ekena dvike guṇite 2 dvikena trike gu° / 6 / ṣaṭkena catuṣke gu° / 24 ⟨/⟩ caturviṃśatau pañcagu° 120 / etāni tanmadhyād ādyena bhuktāni[30] śeṣa / 86 dviguṇa / 172 / dvitīyasya dattāni / 120 bhuktāni śeṣa / 52 / triguṇa / 156 / tṛtīyena (/) 120 bhuktāni śeṣa 36 / caturguṇa / 144 / bhukta 120 śeṣa pañcaguṇa / 120 bhuktāni // //

⟨A13⟩

je jaṇa gahaṃti hatthaṃ te caü(gu)ṇa(ṃ) guṇijja laddhavatthakare /
taṃ vatthadīhavittharakara jaṇa⟨guṇa⟩ caüṇa[31] savvi jaṇā / 11

⟨fol. 2a⟩ ye janā hastaṃ gṛhṇanti (/) te caturguṇāḥ kāryās tato labdhavastrakarair guṇyās tadvastrasya dairghyaṃ vistārarūpaṃ pramāṇaṃ jñeyam / (ida) idam eva karajanair guṇyaṃ catu⟨r⟩guṇaṃ ca[32] sarvasaṃkhyā bhavati /

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25 aṣṭāṃsaḥ.
26 guṇite.
27 egāi uvaruppari in GS.
28 parihi guṇiyaṃti in GS.
29 eṣāājanopaḍhaukitavasolasaṃkhyā.
30 bhūltāni.
31 caügu.
32 sa.

⟨A14⟩ nyāsaḥ ⟨/⟩ hasta 1 / jana / 3 / labdhakara / 9 /⟨/⟩ janāḥ / 3 / caturguṇāḥ /(/) 12 labdhaka⟨ra⟩-/ 9 /-guṇite / 108 idaṃ janais tribhir guṇitaṃ / 324 punaś caturguṇāḥ / 1296 / eṣā sarvajanasaṃkhyā ⟨//⟩ dairghye / 108 / vistareṇa / 108 / guṇite /(/) 11664 / eṣā vastrakarasaṃkhyā // cha //

⟨A15⟩

uvarāuṃ jā hiṭṭhi huiṃ (/) tāṇukkamihiṃ ṭhavijja ⟨/⟩
uvaruppari savve vi guṇi gāvī ima jāṇijja // 12

uparito 'dhastāṅkaṃ yāvad anyonyam aṅkā guṇyāḥ sarvagosaṃkhyā / yathā

⟨A16⟩ 4 / dvārair niḥsaranti gā(/)vaḥ ⟨/⟩ pañca sarassu pibanti / 7 / vṛkṣeṣu sthitāḥ / 9 / pratolīṣu praviśanti / 6 / vaneṣu caranti / 8 / gopai rakṣyante ⟨/⟩ sarvatra samasaṃkhyāḥ ⟨//⟩

nyāsaḥ / 4 / 5 / 7 / 9 / 6 / 8 ⟨/⟩ anyonyaṁ guṇyante / catuṣkena pañcake gu° / 20 / 20 / saptake gu° /140 / anena navake gu° / 1260 / anena ṣaṭke / 7560 / anenāṣṭake / 60480 / iyaṃ sarvagosaṃkhyā // cha //

⟨A17⟩

ciṃtiasua karasahiaṃ biuṇigajua paṃcaguṇa suāsahiaṃ /
dasaguṇa khapaṇakarūṇaṃ sesaṃke muṇaha sunni[33] viṇā // 13 //[34]

cintitaputrāṅkā dvayayutā dviguṇā ekayutāḥ pañcaguṇitāḥ putryaṅkasahitā daśaguṇāḥ 250 (/)-hīnāḥ kriyante ⟨/⟩ śūnyaṃ vinā śeṣāṅkābhyāṃ kramāt putraputrījñānam // cha //

⟨A18⟩

sattariguṇa tiuṇehiṃ[35] (/) paṃcahi(ṃ) igavīsa panara sattehiṃ /
piṃḍeṇa saya paṇuttara devi haravi muṇaha paracintaṃ // 14 /

triguṇe kṛte yac cheṣaṃ tat 70-guṇaṃ ⟨pañcaguṇe kṛte yac cheṣaṃ tat⟩ 21-⟨guṇam⟩ / saptaguṇe kṛte yac cheṣaṃ tat (/) 50[36]-guṇam // eṣām aikye śatamadhye pañcādhikaśataṃ yojyam / śatopari pātyam // iti paracintitāṅkajñānam[37] // 70 / pherūkṛtagaṇitasāre // cha //

Section II

⟨A19⟩

saṃkhyā yāvanmitir dviguṇā syāt sarveṣāṃ samaṃ dhanam ⟨/⟩
dviguṇaṃ bhū/1/naṃ tad ādye syā⟨d[38] eka⟩dvya/2/bdhy⟨ā⟩/4/di tatparaiḥ / 1 /

saptabhūmyādau[39] yāvatsaṃkhyā syāt sā sthānā dviguṇā kriyate // tāvaddhāraṃ tat sarveṣāṃ dhanaṃ sadṛśaṃ bhavati / taddhanaṃ dviguṇaṃ bhuvā / 1 / rahitaṃ prathame sarvotkṛṣṭadhanaṃ ⟨/⟩ tad (/) ekadvicatuṣkāṣṭakaṣoḍaśadvātriṃśadbhir ūnaṃ dvitīyabhūmyādijanānām utkṛṣṭaṃ dhanam ⟨/⟩ yathā

33 sunti.
34 // 12 /.
35 tiūṇehiṃ.
36 51.
37 pari-.
38 sva.
39 -ādi.

⟨A20⟩ saptabhūmayaḥ / 7 / bhūmau bahavo janās tatas tasyāḥ ṣaṣṭhabhūmau yāvata uttīrṇ(ṇ)āḥ ⟨/⟩ evaṃ pratibhūmita uttīrṇ(ṇ)āḥ santas (sa) sarvatra samā jātāḥ ⟨//⟩

64		127 [40]
64		126
64		124
64		120
64		112
64		96
64		64

⟨A21⟩

tribhiḥ pārāpatāḥ[41] pañca ⟨pañca⟩bhiḥ sapta sārasāḥ ⟨/⟩
saptabhir nava haṃsāś ca navabhir varhi⟨fol. 2b⟩ṇas[42] trayaḥ / 2 /
rājaputravinodāya śatena śatam ānaya[43] ⟨//⟩

labdhaṃ[44]

dra	6	pā	10
dra	30	sā	42
dra	28	haṃ	36
dra	36	ma	12

atha vā

dra	15	pā	25
dra	25	sā	35
dra	21	ha	27
dra	39	ma	13

evaṃ śatena // cha //

⟨A22⟩ gatinivṛttau karaṇam /

tyaktvaikadinanivṛttiṃ divasagater ekadinagatiḥ śeṣa⟨ḥ⟩ //

⟨A23⟩ udā // ahīndro divasenaikenār(d)dhāṅgulaṃ[45] navamāṃśasahitaṃ gacchati ⟨/⟩ nivart(t)ate 'ṅgulaviṃśāṃśam ⟨/⟩ tato 'ṣṭādaśahastavivarapradeśo nigadyatāṃ kena kena kāle⟨na⟩

1	1	1	1	18 [46]
1	2	1	20	1
	1			
	9			

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40 This table is written, together with the four tables for A21 and A23, on fol. 2b after the first 'ma' of 'mama' in A25. '32' for '64' in the second column.

41 pārāvatāḥ in PG, GSS, and BG.

42 śikhinas in GSS.

43 Instead of this line, PG has:

rājaputraviodārthaṃ jñātvā mūlyaṃ yathoditam,
śatenaikena rūpāṇāṃ jīvānāṃ śatam ānaya;

GSS has:

krīḍārthaṃ nṛpaputrasya śatena śatam ānaya,
ity uktaḥ prahitaḥ kaścit tena kiṃ kasya dīyate;

and BG has:

drammair avāpyate drammaśatena śatam ānaya,
eṣāṃ pārāvatādīnāṃ vinodārthaṃ mahīpateḥ.

44 The following two tables are written, together with the three tables for A20 and A23, on fol. 2b after the first 'ma' of 'mama' in A25.

45 divasainai-.

46 This table is written on fol. 2b together with those for A20 and A21. '8' for '9' in the second cell, and '2' for the lower '1' in the third cell.

hastānāṃ (/) caturviṃśatyā guṇane /(/) 432 / savarṇ(ṇ)ite jātaṃ

10
18

tato gatinivṛttyoś c⟨h⟩edair anyonyaṃ chedāṃśān guṇayitvā sadṛśacchedatvād gatya⟨ṅ⟩karāśer nivṛttyaṅkarāśiṃ saṃśodhya śeṣacchedas tad eva

⟨91⟩
⟨180⟩

tatas trairāśikavidhinā

91	1	432
180	1	1

[47] madhyarāśim antyarāśinā guṇayitvādyarāśeś chedāṃśaviparyāse 'ṃśair aṃśānāṃ chedaiś ca cchedānāṃ guṇane jātam //

77760
91

ekanavaty⟨ā⟩ bhāge labdham / 854 (/) dināḥ

46
91

[48] dinabhāgāś ca ⟨/⟩ dināṅkasya (//) 360(/)-bhāge labdhaṃ varṣa 2 ⟨/⟩ śeṣasya (/) 30(/)-bhāge labdhā māsāḥ / 4 / dināḥ / 14 // cha //

⟨A24⟩ ratnajātau karaṇam ⟨/⟩

aṃśahīnāḥ kṛtāś[49] ⟨chedāḥ⟩ sāṃśās[50] ⟨te sadṛśe⟩ pṛthak ⟨/⟩
dhanāni[51] te hṛte bhāge(na) ratnamūlyaṃ prakāśayet / 1 /

⟨A25⟩ 'caturbhi⟨ḥ⟩ puruṣai ratnaṃ dṛṣṭvā mūlyaṃ pṛthak pṛthak' sadṛśaṃ proktaṃ[52] yathānyeṣāṃ trayāṇāṃ sarvasvaṃ mama[53] vittār(d)dhena 2 / 1 tribhāga-3-pāda-/ 4 /-pañcamāṃśa-/ 5 /-sahitaṃ ratnamūlyam ⟨//⟩

nyāsaḥ

1	1	1	1
2	3	4	5

chedāḥ svasvāṃśahīnāḥ

1	1	1	1
1	2	3	4

tataḥ sadṛśīkṛtāḥ

12	6	4	3
12	12	12	12

aṃśayutāḥ / 24 / 18 / 16 / 15 / iyaṃ caturṇ(ṇ)āṃ vittasaṃkhyā ⟨/⟩ ratnamūlyam / 61 / tathā labdhaṃ vittasaṃkhyā / 60 / 45 / 40 / 36 / ratnamūlyam / 151 /[54]

⟨A26⟩

rūpona(/)narair vibhājya[55] piṇḍīkṛta(ṃ)bh⟨ā⟩ṇḍasāra(tā)m upalabdham /
syāt sarva(ṃ)dhanaṃ[56] tasmād udyuktavihīna[57]hastagatāḥ / 1 ⟨/⟩[58]

⟨A27⟩ udā° / keci⟨c⟩ catvāro vaṇijaḥ pṛthak pṛthag bhāṇḍasāraṃ prathamo vadet / 22 / dvitīyaḥ / 23 / tṛtīyaḥ / 24 ⟨/⟩ caturthaḥ ⟨/⟩ 27 /

nyāsaḥ / 22 / 23 / 2(/)4 / 27 ⟨/⟩ labdhasarvadhanam / 32 / yuktahīn⟨e⟩ hastagatāḥ / 10 / 9 / 8 / 5 /⟨/⟩ cha //

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47 This table is written on fol. 2b together with those for A20 and A21. '431' for '432' in the third cell.
48 '44' for '46.'
49 kṛtāḥ.
50 sāṃśāḥ.
51 dhanaṃ.
52 prauce.
53 The five tables for A20, A21, and A23 are all written after the first 'ma' of 'mama.'
54 The second set of solutions is faulty.
55 vibhajet in GSS
56 sarvadhanaṃ syāt in GSS
57 uktavihīnaṃ tu in GSS.
58 '0 / e □□□□//' after '1' is deleted with a horizontal line.

⟨A28⟩ samadhane karaṇam /

puru⟨ṣa⟩samāsena guṇaṃ dātavyaṃ tad viśodhya paṇyebhyaḥ /
śeṣaṃ paraspara(ṃ)hataṃ svaśeṣabhaktaṃ[59] maṇer mūlyam / 1 /

⟨A29⟩ udā° / ādyasyendranīlāḥ / 6 / dvitīyasya marakatāḥ / 7 / tṛtīyasya vajrāḥ / 8 / 'ekaikaṃ mitho yathā trayāṇāṃ sadṛśaṃ dhanaṃ' bhavati dātavyam ⟨/⟩ tasya ratnavaṇijaḥ samāsataḥ kiṃ dhanaṃ bhavati ⟨//⟩

nyāsaḥ

6	7	8
1	1	1

dātavyaṃ puruṣa-3-guṇaṃ

6	7	8
3	3	3

paṇyebhyaḥ śodhitam / 3 / 4 / 5 / mitho hatam / 60 / svaśeṣa(ṃ)-⟨3⟩/4/5/-bhaktaṃ labdhaṃ ratnamūlyam / 20 / 15 / ⟨fol. 3a⟩ (/) 12 / trayāṇāṃ samadhanaṃ jātam / 107 / 107 ⟨/ 107⟩ //

⟨A30⟩ dvitīyodā° / ādyasya (/) 12 marakatā⟨ḥ /⟩ dvitīyasya gomedāḥ / 16 ⟨/⟩ tṛtīyasya vajrāḥ / 20 / dvau trayaḥ pañca dātavy⟨ā⟩(/) mitho yathā trayāṇāṃ samadhanam ⟨//⟩

nyāsaḥ

12	⟨1⟩6	20
2	3	5

labdharatnamūlyam / 35 / 30 / 42 / trayāṇāṃ samadhanam / 580 / cha //

⟨A31⟩ vanaphalāgrajātau karaṇam ⟨/⟩

gatena bhāgena phalāni hanyān[60] (/) mukhonitāni dviguṇīkṛtāni ⟨/⟩
cayena bhaktāni ca saikakāni[61] śākhāmṛgāṇām api bhāgasaṃkhyā //

⟨A32⟩ udā° /

kapikulanijatryaṃśo nirgataḥ krīḍanā(nā)rtham (/)
vanagavid api śākhāsv audayitvaikavṛddhyā ⟨/⟩
militaphalavibhāgaṃ pañcakaṃ brūhi dattaṃ
kathaya gaṇaka sākṣād yūthamānaṃ (/ 4) vimṛśya // 1

nyāsaḥ

1	1	1	5
3	1	1	1

[62] labdham ekabhāgasaṃkhyā / 29 / etasya triguṇatve samagrayūthasaṃkhyā / 87 / □yūthasaṃkhyāyāḥ pañcakena guṇane phalasaṃkhyā // 435 // cha //

⟨A33⟩ bhāgabhāgajātau karaṇam //

cheeṇa rūva(ṃ /) guṇie cheagame havaï bhāgabhāgavihī ⟨/⟩
aṃsaṃ juie[63] bhāgaṃ dhaṇeṇa pihugaṃsa guṇa⟨vi⟩ phala⟨ṃ⟩ / 1 // (cha //)

chedena rūpe guṇite cchedagame kṛte sa(ṃ)ty aṃśānāṃ yutiṃ vidhāya tayā svayutyā pūrvaṃ pṛthag aṃśān dhanena guṇayitvā bhāgo hāryaḥ / eṣa bhāgabhāgavidhiḥ // //

59 śeṣaparasparaguṇitaṃ svaṃ svaṃ hitvā in GSS.
60 hanyāt.
61 sā caikakāni.
62 '2' for the lower '1' in the second cell.
63 aṃsāṇa juī in GS.

⟨A34⟩

ega tibhāyadubhāyaṃ egisu navabhāyasattabhāyaṃ ca /
ega chabhāyatibhāyaṃ kiṃ sayadamm⟨āṇa⟩ pihagaphalaṃ /

ādyasya puruṣasya bhāgatrayāṇāṃ bhāgadvayam / anyasya navabhāgānāṃ saptabhāgaḥ // anyasya ṣaḍbhāgānāṃ bhāgatrayam / drammaśate rājyaprasāde datte trayo janāḥ (/) pṛthak pṛthag dhanaṃ kiṃ prāpnuvanti ⟨//⟩

nyāsaḥ

1	1	1	100
3	9	6	1
2	7	3	

chedena rūpe guṇite chedagame ca[64] jātam

2	7	3
3	9	6

[65] chedābhyām anyonyaṃ kṛte jātaṃ chedasādṛś⟨y⟩am

12	14	9
18	18	18

aṃśayutau 35 / aṃśānāṃ pṛthak pṛthak phalena guṇanārthaṃ nyāsaḥ / 12 / 14 / 9 ⟨/⟩ śatena dvāda⟨śa⟩ke guṇite / 1200 / aṃśayutyā / 35 bhāge labdham

34
10
35

ayam ādyasya bhāgaḥ / śatena caturdaśake guṇite / 1400 / a⟨ṃ⟩śa(ṃ)yutyā / 35 bhāge labdham 40 / ayaṃ dvitīyasya bhāgaḥ / śatena navake guṇite / 900 / a⟨ṃ⟩śa(ṃ)yutyā / 35 / bhāge labdham

25
25
35

ayaṃ tṛtīyasya ⟨//⟩

⟨A35⟩ dvitīyodā° /

vāpī catu⟨ḥ⟩praṇālā yāmād dvābhyāṃ tribhiś caturbhiś ca ⟨/⟩
kramaśaḥ pṛthag vimuktai⟨r⟩ yugapat[66] pūrṇ(ṇ)ā kiyat kālam ⟨//⟩

nyāso yathā

1	1	1	1
1	1	3	1
4	2	4	1

[67] rūpe cchedahate / chedagame ca

4	2	4	1
1	1	3	1

[68] sadṛśacchedāṃśayutiḥ

25
3

dinapramāṇaṃ ghaṭī 30 / bhinnabhāgārthaṃ harasya cchedāṃśaviparyāye[69] nyāsaḥ

3	30
2⟨5⟩	1

guṇane labdham

90
25

labdhaṃ ghaṭikā / 3 / pala 36

(

25
25

) ⟨//⟩

⟨A36⟩ vāpībharaṇānayane 'nyat karaṇasūtram /

chiḍāṃ lavānāṃ ca viparyaye kṛte (/) tadaik⟨yahārāṃśa⟩viparyaye punaḥ /

⟨A37⟩ udāha° /

---

64 chedāegameva.
65 '2' for '3' in the first cell.
66 guṇapat.
67 '3' for the bottom '1' in the last cell.
68 '3' for the upper '1' in the last cell.
69 viparyāna.

vimalatamapayobhiḥ pūrayanti (/) praṇālyo
dalacaraṇaṣaḍaṃśatryaṃśakair[70] vāsarasya ⟨/⟩
yuga⟨fol. 3b⟩pad[71] yadi vimuktās[72] tāḥ kadā hanta vāry⟨ā⟩ṃ (/)
vidadhati (/) jalapūrṇ(ṇ)ā brūhi ced[73] vetsi pāṭīm[74] / 1 /

1	1	1	1	labdhaṃ vāpīpūraṇakālo dinabhāgaḥ[75]	1
2	4	6	3		15

⟨A38⟩

bhajec chido[76] 'ṃśair atha tair vimiśrai rū⟨paṃ⟩ bhajet syāt[77] paripūrt(t)ikālaḥ //

⟨A39⟩ udā° /

ye narmarā[78] dinadinārdhatṛtīyaṣaṣṭhaiḥ[79] sampūrayanti hi pṛthak pṛthag eva muktāḥ /
vāpīṃ yadā yugapad eva sakhe[80] vimuktās te kena vāsaralavena tadā vadāśu / 1 /

1	1	1	1 [81]	labdhaṃ vāpīpūraṇakālo dinabhāgaḥ[82]	1
1	2	3	6		12

⟨A40⟩

vāvi cha kara caü nālaya[83] bharaṃti kami diṇigi dali ti caüraṃsaṃ /
jaï samakāli vimuccaï[84] (/) tā pūraï (/) kittieṇa[85] kālena ⟨//⟩

nyāsaḥ

⟨1⟩	⟨1⟩	⟨1⟩	⟨1⟩
1	1	1	1
1	2	3	4

rūpe cchedena guṇite cchedagame ca

1	2	3	4 [86]
1	1	1	1

chedasādṛśyād yuktau / 10 / dinasya daśāṃśena pūrayanti / pūrvavat kṛte labdhaṃ yathākramam

0	1	1	2
6	2	8	4
10	10	10	10

ime pratinālakaṃ hastā aṃśāś ca / eṣā sarvāpi bhāgabhāgajātiḥ //

70 dalavaraṇa-.
71 yugapaga.
72 vimūktās.
73 ce in margin.
74 pāṭiṃ.
75 -bhāgā.
76 chidā.
77 bhājet syāva.
78 nargarā. nirjharā in L.
79 dinäddharddha-.
80 saṣe.
81 '2' for the lower '1' in the first cell.
82 -bhāgāḥ.
83 caütālaya.
84 ti muccahi in GS.
85 kena in GS.
86 '2' for the lower '1' in the first cell.

⟨A41⟩

ardhaṃ gataṃ vāri gajendrayūthāc[87] cheṣa(s)tribhāgo vipine praviṣṭaḥ ⟨/⟩
reme girau śeṣacaturthabhāgo dṛśyaṃ trayaṃ tatra gajā⟨ḥ⟩ kiyantaḥ /⟨/⟩1 //

nyāsaḥ

1	1	1	1	1	1
1	2	2	3	3	4

khaṇḍatraye 'py aṅkānāṃ parasparaguṇane jātam

1	1	1
2	6	12

chedābhyām anyonyaṃ kṛte

9
12

rūpāt tyakte / 3 ⟨12⟩ / tato dṛśyatrikasya dvādaśabhir guṇane / 36 / tatas tribhir bhāge labdhaṃ gajāḥ / 12 / eṣā prabhāgajātiḥ //

⟨A42⟩ // śrīpuṣpagranthanikāprakāreṇāṅkag⟨u⟩ṇanaṃ yathā // ⟨*lacuna*?⟩ atra prāyo yuktidvaye 'pi tāvanta evāṅkāṅkāḥ syuḥ ⟨/⟩ anyathār(d)dhapuṣpagranthaniketi yathā / 256 / rū ⟨/⟩ rūpasyāṅkasya svenaiva cādhaüparibhāvena samapaṅktyā⟨ṃ⟩ saṃsthena[88] guṇane ṣaṭkaḥ sarvā(r)gre sthāpyate / trikasya pṛthak pṛthak / tata⟨ḥ⟩ ṣaṭkasya ⟨pañcakena pañckasya⟩ ṣaṭkena guṇane pūrvatrikamīlane ca jātas triṣaṣṭes trikaḥ pūrvalabdhasya ṣaṭkasya paścā⟨t⟩ sthāpya⟨te /⟩ ṣaṭkaś ca pṛthak ⟨/⟩ tato dvikena (na) ṣaṭkasya ṣaṭkena dvikasya pañcānāṃ pañcabhi⟨r⟩ gu(r)ṇane pūrvasthāpitaṣaṭkakṣepe ca jātaḥ // 55 / rūpaḥ / ekaḥ pañcakaḥ pūrvalabdhatrikasya paścāt sthāpyate dvitīyaś ca pṛthak / tataḥ pañcakasya dvikena dvikasya pañcakena guṇane ⟨pūrvasthāpitapañcakṣepe ca jātaḥ / 25 / pañcakaḥ pūrvalabdhapañcakasya paścāt sthāpyate / dvikaś ca pṛthak / tato dvikasya dvikena guṇane⟩ pūrvasthāpitadvikṣepe ca ṣaṭkarūpo[89] 'ṅkasarveṣāṃ paścāt sthāpyate / sthāpanā yathā // 65536[90] // evam anyatrāpi samaviṣamāṅkabhāve 'pi jñeyam // // iti kiñcid aṅkaguṇanaprakāraḥ samāptaḥ // //

svagurūṇām upadeśād gaṇitavidhir g(r)a(ta)ṇitaviccamatkṛtikṛt ⟨/⟩
śrīmaccampakadrugre ⟨*lacuna*?⟩ // / cha //

Section III

⟨A43⟩ atha ⟨sa⟩ptarāśikodāharaṇam //

dvikavyāso 'ṣṭakāyāmaḥ kambalo labhate daśa ⟨/⟩
tato 'nyau[91] trikaravyāsau[92] (/) navāyāmau kim āpnutaḥ[93] / 1 /

nyāsaḥ

1	2
2	3
8	9
10	0

labdhaṃ rūpāṇi

33
3
4

evaṃ saptarāśikaṃ samāptam // cha //

⟨A44⟩ ⟨fol. 4a⟩ atha navarāśikodāharaṇam //

---

87 yuthāc.
88 saṃsthā.
89 paṭkarūpo.
90

2	5	6
2	5	6

Probably this should replace '256' above.

91 'nyo.
92 dvau trikavyāsau in PG and Tr.
93 āpnutāṃ.

āyāmavyāsapiṇḍeṣu navapañcaikahastakā /
labhate 'ṣṭau śil(y)ānye[94] kiṃ daśasaptadvihastake // 2 /⟨/⟩

nyāsaḥ

1	2
9	10
5	7
1	2
8	0

labdham

49
7
9

⟨A45⟩ atha dvitīyodā° //
dvivyāsaṣaḍucchrāyasaptāyāmasya[95] hastino[96] droṇaḥ /
trivyāsa(sa)nava⟨sa⟩mucc⟨h⟩rayadaśadairghyagajasya kiṃ bhuktau[97] / 3 /

nyāso yathā

1	1
2	3
6	9
7	10
1	0

droṇāḥ ⟨3 /⟩ āḍhakasthāne[98] 0 ⟨prasthāḥ 3 /⟩ kuḍavaḥ 1 / tadbhāgāḥ
0

15
21

evaṃ navarāśikaṃ samāptam // cha //

⟨A46⟩ bhāṇḍapratibhā⟨ṇ⟩ḍake karaṇasūtram āryāpūrvār(d)dham ⟨/⟩
viparītakṛte[99] mūlye[100] bhāṇḍapratibhāṇḍake vidhiḥ pūrvaḥ ⟨//⟩

⟨A47⟩ prathamodā° /
śuṇṭhyā⟨ḥ⟩ paladvayaṃ ṣaḍbhiḥ piṣpalyā[101] navabhi⟨ḥ⟩ paṇaiḥ[102] ⟨/⟩
tataḥ śuṇṭhīpalaiḥ ṣaḍbhiḥ piṣpalī[103] kiyatī bhavet // 4 ⟨//⟩

nyāsaḥ

6	9
2	1
6	0

labdhaṃ pale dve 2 //

⟨A48⟩ dvitīyodā° /
paṇābhyāṃ 2 ṣoḍaśā(ṃ)mrāṇi / 16 / kapitthānāṃ śataṃ / 100 tribhiḥ /
ṣaḍbhi(ḥ)r ām⟨r⟩aiḥ 6 kapitthāni[104] (/) labhyante kati kathyatām / 5 /[105]

94 labhyante 'ṣṭau śilādve in Tr.
95 -ṣaṭsamucchraya- in PG and Tr. The phrase, 'piṃḍeṣu navapaṃcaikahastakā / labhate 'ṣṭau śilyānye,' written between 'ḍu' and 'cchrā' is deleted by drawing a horizontal line.
96 hastito. dantino in PG.
97 bhūktau.
98 aḍhaka-.
99 viparīte kṛte.
100 viparītīkṛtamūlye in PG.
101 pippalyā in PG and Tr.
102 palam in PG.
103 pippalī in PG and Tr.
104 kapitthāmri.
105 tāṃ / 5 / in margin.

nyāsaḥ

2	3
16	100
6	0

labdhaṃ kapitthāni 25 /

evaṃ bhāṇḍapratibhāṇḍakaṃ samāptam // cha //

⟨A49⟩ jīvavikraye karaṇasūtram āryāparārdham /

jīvasya vik⟨r⟩ayaḥ syād vayasaḥ parivart(t)ane sa eva vidhiḥ / 6 /[106]

⟨A50⟩ prathamodāharaṇam /

ṣoḍaśavarṣā nāryaḥ[107] pañca la(ṃ)bhante śatadvayaṃ vidvan /
tat kiṃ viṃśativarṣe dve ca[108] labhete tad ācakṣva[109] // 7 //

nyāsaḥ

16	20
5	2
200	0

labdham / 64 /

⟨A51⟩ dvitīyodā° ⟨/⟩

daśavarṣoṣṭratritayaṃ (/) purāṇaśa⟨ta⟩m aṣṭasaṃyutaṃ labhate /
tat kiṃ na⟨va⟩varṣoṣṭrāḥ pañca labhante tad ācakṣva[110] /⟨/⟩/ 8 //

nyāsaḥ

10	9
3	5
108	0

labdham purāṇāḥ / 200 //

evaṃ jīvavikrayaḥ[111] samāptaḥ // cha //

⟨A52⟩ stambhoddeśakajātau karaṇasūtram āryāpūrvār(d)dham /

stambhāṃśaikyaṃ tyaktvā rūpāc cheṣeṇa saṃbhajed dṛśyam /

⟨A53⟩ prathamodāharaṇam /

ar(d)dha(ṃ)ṣaḍaṃśadvādaśabhāgā jalapaṅkavālukāntaḥsthāḥ[112] /
dṛśyaṃ hastadvitayaṃ (/) kathaya sakhe stambhaparimāṇam // 9 /⟨/⟩

nyāsaḥ

1	1	1	1	2
2	6	12	1	1

labdhaṃ hastāḥ | 8 |

⟨A54⟩ dvitīyodāharaṇam //

---

106 PG has:

jīvasya vikraye syāt sa eva parivartite vayasi;

and Tr has:

jīvasya vikrayaḥ syāt sa eva parivarttate vayasi.

107 nāryāḥ. ṣoḍaśavarṣāṇāṃ yadi in Tr.
108 Instead of 'dve ca,' PG has kathaya, and Tr ubhe.
109 samācakṣva in PG, mamācakṣva in Tr.
110 samācakṣva in PG.
111 jīvavikrayāḥ.
112 jasapaṃka-.

ar(d)dhaṣaḍaṃśadvādaśabhāgā jalapaṅkavālukā⟨n⟩taḥsthāḥ /
dṛśyo[113] hastaḥ sār(d)dhaḥ kathaya sakhe stambhaparimāṇam / (6)10 //

nyāsaḥ

1	1	1	1	1
2	6	12	1	1
				2

[114] labdhaṃ hastā⟨ḥ⟩ // 6 //

evaṃ stambhoddeśakajātiḥ // cha //

G.3 Manuscript B

⟨fol. 4b⟩ //

⟨B1⟩

tryaṃ 3 ghri 4 ṣaḍaṅ 6 kā 9 rkāṃ 12 śā lohatraputāmrarajatahemabhuvi ⟨/⟩
ṣaṇmaṇikhanau ca jagmuḥ kati te puruṣāḥ kathaya vidvan 1

sarva 108 ⟨//⟩

⟨B2⟩

kāminyā hāravalleḥ[115] suratakalahato mauktikānāṃ truṭitvād
bhūmau yātas tribhāgaḥ śayanatalagataḥ pañcamāṃśaś ca dṛṣṭaḥ ⟨/⟩
prāptaḥ[116] ṣaṣṭhaḥ sukeśyā gaṇaka daśamakaḥ saṅgṛhītaḥ[117] priyeṇa
dṛṣṭaṃ ṣaṭkaṃ ca sūtre kathaya katipayair mauktikair eṣa hāraḥ 1

sarva 30 ⟨//⟩

⟨B3⟩

ar(d)dhaṃ gataṃ vāri gajendrayūthāt śeṣatribhāgo vipinaṃ praviṣṭaḥ ⟨/⟩
reme girau śeṣacaturthabhāgo dṛśyaṃ trayaṃ tatra gajāḥ kiyantaḥ 1

sarva 12 ⟨//⟩

⟨B4⟩

s(v)aṣaṣṭhāṃśatryaṃśaṃ dhuri nijatrikāṃśena sahitaṃ
caturthāṃśaṃ turyāṃśakayutanavāṃśa⟨ḥ⟩ parapadaḥ ⟨/⟩
tṛtīyāṃśenāḍhyaṃ dvyadhikadaśamāṃśakaṃ vyatītavāṃś
catustīrthyaṃ śeṣās traya iha suvarṇāḥ kati same 1

sarva 108 ⟨/⟩ tat katham ⟨/⟩ tṛtīyāṃśaḥ 36 tatṣaṣṭhāṃśa-6-yutāḥ 42 ⟨/⟩ caturtho 'ṃśaḥ 27 tattṛtīyo 'ṃśaḥ 9 yutāḥ 36 ⟨/⟩ navamo 'ṃśaḥ 12 taccaturthāṃśa-3-yutāḥ 15 ⟨/⟩ dvādaśo 'ṃśaḥ 9 tattṛtīyāṃśaḥ 3 yutāḥ 12 ⟨/⟩ śeṣatrikayutāḥ sarve 108 ⟨//⟩

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113 dṛśyā.
114 2 in the last cell.
1
115 -vatyāḥ in Tr.
116 āttaḥ in Tr.
117 saṃgrihītaḥ.

⟨B5⟩

yūthārdhaṃ 504 satribhāgaṃ 168 girivivaragataṃ[118] kuñjarāṇām adṛśyaṃ[119]
ṣaḍbhāgaś caiva nadyāṃ 168 pibati ca salilaṃ saptamāṃśena[120] 24 yuktaḥ ⟨/⟩
padminyām aṣṭabhāgaḥ 126 svanavakasahitaḥ 14 krīḍate 'sau taṭāke[121]
nāgendro hastinībhis tisṛbhir[122] anugataḥ kā bhaved yūthasaṃkhyā 1

sarva 1008 ⟨//⟩

⟨B6⟩

gaccho vāñchābhyasto vāñchayuto[123] gacchasaṃguṇaḥ kāryaḥ ⟨/⟩
dviguṇīkṛtavāñchah⟨ṛ⟩te[124] vadanti saṅkalitam āryās tat[125] 1

⟨B7⟩

saikapadāhatapadadalam ekādicayena bhavati saṅkalitam ⟨/⟩
dviguṇīkṛtasaṅkalitān mūlaṃ gaccho 'vaśiṣṭasamam 1

⟨B8⟩

śabdena guṇayed icchāṃ śabdaṃ tu prakṣipet tataḥ ⟨/⟩
icchayā tāḍitaṃ kuryād dvighnaśabdena bhājayet 1

⟨B9⟩

tri huṃ sattari pāṃca igavīsa sāte lādhe puṃṇī vī ⟨/⟩
sa paṃcottaraso ṇaḍī kahi cintayī yā ruṃ te nara lahi 1

asyārtho gurumukhāt //

⟨B10⟩

ardhaṃ toye kardame dvādaś⟨ā⟩ṃśaḥ ṣaṣṭho bhāgo vālukāyāṃ nimagnaḥ ⟨/⟩
sār(d)dho hasto dṛśyate yasya tasya stambhasyāśu brūhi mānaṃ vicintya 1

sarva 6 ⟨//⟩

⟨B11⟩

ar(d)dhatryaṃśadvādaśabhāgā jalapaṅkavālukāntassthāḥ ⟨/⟩
dṛśyaṃ hastacatuṣkaṃ brūhi sakhe stambhaparimāṇam 1

⟨sarva 48 //⟩

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118 giriśikharagataṃ in Tr.
119 ca dṛṣṭaṃ in Tr.
120 saptabhāgena in Tr.
121 jātarāgo in Tr.
122 tribhir.
123 vāñchāyuto.
124 -vāñchāhate.
125 'ācāryāḥ' in the citation by Abhayadeva.

⟨B12⟩

ekadvitricaturyāmair dīrghakā pūry(y)ate pṛthak ⟨/⟩
yugapat pūraṇe ghaṭyas[126] tisraḥ palāni ṣaḍguṇāḥ 1

⟨B13⟩

ṣaḍbhāgaḥ pāṭalāsu[127] bhramaragaṇayutaḥ[128] sa tribhāgaḥ[129] kadambe
pādaḥ cūtadrumeṣu[130] pradalitakusume campake pañcamāṃśaḥ ⟨/⟩
protphullāmbhojakhaṇḍe[131] himakaradalite[132] triṃśadaṃśo niviṣṭaḥ[133]
tatraiko mattabhṛṅgo bhramati ca gagane kā bhaved yūthasaṃkhyā[134] 1
sarva 60 ⟨//⟩

⟨B14⟩

goyūthaṃ 4095 tri pathagataṃ 1365 pañca gopālarakṣitam 819 ⟨/⟩
sapta[135] nadyāṃ 585 pibet toyaṃ nava vṛkṣaiḥ 455 sthitaṃs tadā ⟨/⟩
trayodaśair dohita⟨ṃ⟩ 315 nūnaṃ kiyanto gāva saṃkhyayā ⟨/⟩
vada vidvan mahārājan kathitaṃ gaṇakottama 1
sarva 4095 gosaṃkhyā // [136]

⟨B15⟩

nālī kerī atiuṃ caluṃ be bhara bhāra dharījjaï ⟨/⟩
ādhāluṃ bi lagga bhāga cotho dhaṇī lījjaï ⟨/⟩
aṣṭamāṃśa adṛṣṭa chaï ṣoḍaśāṃśako hy osahī ⟨/⟩
solasāṃsa sāvaja cūṇyo prītivijaya saṃkhyā kahī 1
sarva 104 ⟨//⟩[137]

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126 ghaṭyās.
127 pāṭalīṣu in GSS.
128 bhramati gaṇayutaḥ in Tr, bhramaravaratates in GSS.
129 svatribhāgaḥ in Tr, tattribhāgaḥ in GSS.
130 -drume ca in Tr.
131 -ṣaṇḍe, so also in GSS.
132 ravikara- in Tr and GSS.
133 'bhireme in Tr and GSS.
134 bhramati nabhasi cet kā bhaved bhṛṅgasaṃkhyā in Tr, bhramati nabhasi kā tasya vṛndasya saṅkhyā in GSS.
135 satha.
136 Notes in margin:

	1365	
	819	
	585	
	455	
	315	
sarva	3539	
	556	kṣepya //

The mathematical purport of B14 seems to be: $\frac{x}{3} + \frac{x}{5} + \frac{x}{7} + \frac{x}{9} + \frac{x}{13} + 556 = x$. The last line, '556 kṣepya' ('556 should be added'), probably points out that the term '556' is not stated in the problem.

137 Notes in margin:

	52
	26
	13
	6
	6
sarva	103
śeṣa	1

⟨B16⟩

nāli kera thāiṃ ⟨the end of fol. 4b⟩

The details of B15 are not clear to me, but the mathematical purport seems to be: $\frac{x}{2}+\frac{x}{4}+\frac{x}{8}+\frac{x}{16}+\frac{x}{16}=x$, which any x satisfies. The remainder 1 mentioned in the notes ('śeṣa 1') originates from the two 6's, which are approximations to $\frac{104}{16}$ or $6\frac{1}{2}$.

APPENDIX H

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* For more bibliographical information about Indian mathematics, see Pingree 1970/81 and Pingree 1981 in H.2.

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APPENDIX I

Glossary-Index of Sanskrit Words

This glossary-index contains all the Sanskrit words that have been identified, and a few that have not been identified, of the *Bakhshālī Manuscript*. References are given not only to the Sanskrit text but also to the places (whose page-numbers, etc. are italicized) of Introduction, Translation, Commentary, and Appendices, where their meaning and use are discussed or mentioned.

Nouns and adjectives are, as a rule, cited in their stem forms. Inflected pronouns are given under their basic stems, and so also are different stems of numerals. Inflected verbs are cited under their roots. Irregular words are listed under the corresponding regular forms. Abbreviations are listed under their original forms in so far as they have been identified.

Notation

For words:

- A (= B): the word A corresponds to the regular Sanskrit B.
- A⟨B⟩: A is an abbreviation of the word AB (e.g., a⟨śva⟩).

For references:

- (N): the word, restored in N, is partially preserved in the manuscript.
- ⟨N⟩: the word, restored in N, is entirely lost in the manuscript.
- NF: the word occurs in an unlocated fragment that belongs to N in the Bodleian arrangement of the leaves.

aṃśa	*a part, factor* I 3, II 4, 10, III 1, 4, 20, 25, VII 1, ⟨3⟩, (4), 5, (7), 9, (VIII 4), X 8, ⟨14⟩; aṃ⟨śa⟩ X 16; aṃśaka III ⟨1⟩, 33; aṅśa I 2, III 1, VII 5; aśa VIII 4 (harāśau); *60, 430*
akṛti	*a non-square number* III 12, VII (3), 6; *431, 434, 459*
akṣauhiṇī	*the largest unit of an army* (X 23); a⟨kṣauhiṇī⟩ X 22; akṣāhanī X 23; akṣohiṇī X 23; akṣauhinī (X 23); *133–135, 428, 456*
aṅka	*a numerical figure* ⟨IV 7, VI 1⟩; aṃka (VI 2), VII 4
aṅga	*a limb or member of the body* aṃga X 14
aṅgula	*a unit of length* a⟨ṅgula⟩ X 10; aṃ⟨gula⟩ X 6; aṃgula X 6, (7); *114, 115, 144, Table 12.8*

ajñāta	*unknown* III 28, (36), V 3
aṇḍikā[1]	*a unit of weight* a⟨ṇḍikā⟩ X 5; aṃ⟨ḍikā⟩ X 1, 2, 3, ⟨13⟩, 20 aṃḍikā X 2, (20); āṇḍikā X 4; *119, 121, 122, 125, 126, 129, Tables 12.14, 12.15*
aṇḍikā[2]	*a monetary unit* X 2, 7; *118, Table 12.9*
atas	*therefore, from it* ⟨II 5, III 3, 18⟩; ato I 17, III 2, 16, 23, IV 5, 12, VIII 1, 8
atra	*here* (I 3), II 10, III 17, 18, IV (5), 8, V i, VI 4, X (5), 14, 25; attra I 7
atha	*now* I (7), ⟨9⟩, III 3, 18, 19, 22, (27), 30, IV ⟨2⟩, 5, ⟨8⟩, 12, V ⟨3⟩, 6, VIII 8, 10, IX 1, X 3
adas	*this* aśau (= asau) X 9; sau (= asau) X 8; *44*
adhas	*lower* adha I ⟨3⟩, 10, IV 7, V 6, (VII 3), IX 4, X 8, 10, 11, ⟨12⟩, (13), 16, 17, 17F, 21; *48, 51, 60, 458*
adhika	*large, increased by* ⟨I 3⟩, II 9, III (8), 14, IV (7), 8, V 6, X 18; *457*
adhunā	*now* IX 4
adhyardha	*one and a half* ⟨II 5⟩, (X 14); addhyardha III 6, 21; divardha I 14, III 21, IV 8, 9, X 4, 26; divardhaka VIII 5; *47, 52*
adhvan	*a road, way* III 18; adhvānaṃ (= adhvā) III ⟨10⟩, 11; *43, 51*
anantara	*without an interval* naṃtara VII 13
anīkinī	*a division of an army* X 23; nīkinī ⟨X 23⟩; *134, 428, 455, 456*
anu	*after* IV 11
anukrama	*succession, order* anukkrama VI 3
anupūrvaśas	*in order* anupūrvaṣas II 7
anta	*end* ⟨III 28⟩
antara	*difference* aṃtara (III 8)
anya	*other* I 9, III ⟨20⟩, 22, 25, 26, 27, 30, (VII 8), X 4, 22; aṇya (X 25)
anyonya	*mutually* III 3
anvaya	*accompanied by (in the sense of multiplication)* IV 4; *315, 458*
anvita	*accompanied by* X 10?
apara	*another* II 7, IV ⟨4⟩, 9, VII 11, X (5), 19, (24), 25, 26
apavṛt	*to reduce (fractions)* apavarta (X 26); *82, 83, 458*
apahṛ	*to take away* apaharaṃti X 6
apahṛta	*taken away* III 27, (VIII 10)
api	*also* II 10, III 2, 7, 8, 27, V 3, X 11, 24, ⟨25⟩
aprāpta	*impurity (of gold)* III 35, 36; *53*
abda	*a year* X 13
abhāga	*one that has no part or share* I 14, (V 3)
abhidhā	*to call, name* abhidhīyate ⟨X 22, 23⟩
abhilikhita	*written* III 6, 7, X 25; *84, 85*
abhyasta	*multiplied* III 36; *458*
abhyāsa	*multiplication, a product* (III 1), VI 4; *93, 458*
ambu	*water* aṃ⟨bu⟩ V 2; āṃbu V 2
ambha	*See* aśman.
ambhas	*water* aṃbhas III 23; aṃbha III 23; *51*
argha	*price* arha VII 11?
arj	*to earn* ārjayate (= arjati) VIII 4; ārjaye (= arjet) VIII 3, 4; *49*
arjana	*earning* ā⟨rjana⟩ ⟨IX 1⟩; ārjana ⟨VIII 3⟩, IX 1; ārja VIII 3; *51*
arjanīya	*to be earned* X 7
arjuna	*a proper name* (X 14); *135, 460*

artha	*meaning, purpose* III 30, IX 2, X 24F, 27
arthin	*wishing for* IX 2, X 13
ardha	*half* I 2, (7), 9, II 3, 5, 8F, 9, (10), III 1, 2, 14, 15, IV (1), 2, 6, 7, 8, 9, 11, VI 1, VII 4, ⟨9⟩, IX 2, 3, X 6, 7, 8, (9), 12, 14, 15, 16, 19, 24, 25, 26; addha (VII 11); ārdha X 6?; *54, 91, 458*
arha	*worthy of, price* VII 11 (= argha?); *54*
alpa	*small* III 18
avasāna	*end* X 27
aśīti	*eighty* II 9
aśuddha	*inaccurate* VII 3, 6
aśman	*a stone* ambha (= aśma-) III 28; *51*
aśva	*a horse* II 1F, 6, 9, III 5, 16; a⟨śva⟩ III 5; asva (III 16)
aṣṭa(n)	*eight* ⟨I 14⟩, III 10, 24, ⟨34⟩, VII 8, IX 2, X 11, 12, (13); aṣṭha III 7, 9, 10, 19, 20, 25, IV 12, VII 1, (6), VIII 8, X 18; āṣṭa (I 14?)
aṣṭatā	*the state of being eight* X 11
aṣṭama	*the eighth* X 12
aṣṭādaśa	*the eighteenth* aṣṭhādaśama (III 9); aṣṭādaśī X 11
aṣṭādaśa(n)	*eighteen* ⟨VI 2⟩, X 6; aṣṭhādaśa III 7, 21, (VII 13), VIII 6; ṣṭhādaśa V 3; *46*
aṣṭāviṃśati-tama	*the twenty-eighth* aṣṭhāviṃśatima (III 36)
as	*to be* asti III 1, 8, VIII 3, X 2, 20, 21, 22F; astu X 9; āsīt IV 8; sati (II 2); santi VIII 5; syā (= syāt) II 2, III 28; syāt I 7, ⟨II 1⟩, VI ⟨1⟩, 2, ⟨VII 7⟩, (X 5, 9)
ah	*to say* āhu (= āhuḥ) I 14?; āhuḥ X ⟨22⟩, 23
ahan	*a day* III 14, 15, VIII 5, X 2, ⟨12⟩, 13, (16); aha- (= ahaḥ) VIII 4, 5; *51*
ā⟨?⟩	*a measure* X 17; *131*
ā⟨?⟩	X 24F
āṃ⟨?⟩	I 3 (*a synonym of* vrīhaka = vrīhika)
ākram	*to surpass* ākramya (III 18)
āgata	*come* III 18
ācakṣ	*to tell* ācakṣva III 17
āḍhaka	*a unit of weight* III 23; ā⟨ḍhaka⟩ III 26; *116, 117, 121, 123, Table 12.13*
ātman	*self* (I 18), III 9, (10), 14, X 22, 27; āpa I 4; *51*
ātmavaptṛka	*a landed farmer* āpavaptṛka I 4; *51*
ādi	*beginning, the first term of a mathematical progression* I 10, III 8, 9, 10, 11, (13), 14, 15, ⟨17⟩, 34, VI 1, 2, VII 1, 5, 6, 8, 10, X 19; ā⟨di⟩ III 8, 9, 11, 14, 15, 17, IV 4, VII 1, 5, 8; āia (= ādika) VII 11; āda (= ādi) X 17; ānī (= ādīn) VI 2; *54*
ādima	*first* VI 1
ādiś	*to point out* ādiśatu (III 6); ādiśet I 10, VI 1; ādisāt (= ādiśet) (VIII 9); *50*
ādya	*first* II 9, III ⟨7⟩, 9, V 1, VI 1, (2), X 27
ānana	*the face* āṇana X 9
ānayana	*calculation* III 17
ānī	*to obtain, compute* ānaya I 15, (III 36, IV 9, VIII 10); ānayasva III 12
ānīta	*obtained, calculated* āṇīta III 24
āp	*to reach* āpnayā (= āpnuyāḥ) III 35; *49*
āpa	*See* ātman.
āya	*gain* VIII 3, IX 1, 4, X 19

āruh *to climb* āruroha (X 8)
ārj *See* arj.
ārjana *See* arjana.
āvartita *turned round, melted (into a single alloy)* III 36; *313*
āvṛtti *the original quantity* III 23; *53, 303*
āśu *quickly* VIII 5, ⟨X 18⟩
āśraya *an abode* X 8
āhata *struck* X 3 (*in* pālāhata), 12
āhvaya *a name* (III 17)

icchā[1] *wish* V 6
icchā[2] *an optional number* IV 5, VI 1, 2; *439*
iti *thus* II 1, ⟨5⟩, III ⟨12, 16⟩, 20, 22, 23, 29, 30, 31, 32, 35, ⟨36⟩, VIII 2, X ⟨18, 22, 23⟩, 24
idam *this* III 21, (32), (X 27); anayoḥ ⟨VIII 3⟩; anena I 10, 12, 17, II 2, 5, ⟨6⟩, 7, (8), 9, III 9, ⟨10⟩, (11), 12, 13, ⟨14⟩, 17, 18, 20, 23, 24, 27, 28, 31, 32, 33, 34, IV 6, 9, ⟨11⟩, V 1, VII 7, VIII 2, ⟨3⟩, 5, ⟨6, 7, 8, 9⟩; ayaṃ (II 7F), III 1, 17, 18, VI 2, VIII 3; asya I 3, 10, II 3, 6, 10, III 4, 10, (14), 26, 27, 28, 31, IV 3, 12, VII 4, ⟨5⟩, 7, 9, ⟨10⟩, VIII 2, 7, 10, IX 3, X 3, 5; ime III 33; ebhiḥ III (7), ⟨10⟩; eśāṃ (= eṣāṃ) III 34; eṣā (= eṣāṃ) II 5, IV 11, III 32; eṣāṃ I 8, II 7, 8, III 2, 4, 32, IV 2, ⟨3⟩, (4), 6, ⟨7⟩, (9, 10), X 11, 24; sya (= asya) VIII 7, IX 3; *44*
idānīm *now* idānī III 32
iyat *this much* iyatā X 14
iṣ *to wish, desire* icchāmi X 13
iṣṭa *desired, an optional number* ⟨IV 7⟩; iśta IV 7; *375, 377, 396, 397*
iha *here* I 4

ukta *told* III 1, (15), (VI 3), ⟨X 21⟩
ucchrita *elevated* ucchṛta X 8
ujjhita *removed, subtracted* III 26, 35, VII 1, (6, 8); *457*
uttama *best* III (11), 14, 25, 34, ⟨IV 7, VI 2⟩, VIII 8, IX 3, X 10, 15
uttara *excess, difference* II 1, 5, 7, 8, III 7, 9, 10, 11, 12, ⟨13⟩, 14, 15, 17, 19, 20, 34, VII 1, 5, (6), 7, (8), ⟨10⟩; u⟨ttara⟩ III 8, 9, 11, 14, 15, 17, IV 4, VII 1, 5, 8; unnara III 8; *393, 457*
utpanna *produced* utpaṃnna X 27; utpaṇṇa VIII 8
utpatti *product* utpati IX 2
udara *the belly* V 5; *401*
udāharaṇa *an example* I 8, V 6, X 2, (6); udā⟨haraṇa⟩ I 1, 2, 4, ⟨15⟩, II ⟨2⟩, 6, 7, 9, III 1, 3, 6, 7, 8, 11, ⟨14⟩, 15, ⟨16⟩, 17, 19, 20, 21, ⟨23⟩, 24, 25, 26, 27, 28, 31, 32, 33, (35), 36, IV 1, ⟨5⟩, 6, ⟨7⟩, 8, 9, ⟨V 5⟩, VI 1, ⟨2⟩, (VII 13), VIII 2, 3, (4), 6, 7, 8, 9, 10, IX (2), 4, X 4, (5), 7, 8, 9, 10, ⟨11, 13, 14, 15⟩, 16, 17F, ⟨21⟩, (22, 23), 25F, 26; *84, 85, 87, 142*
udbhū *to arise, appear* udbhavet III 16
udvardha *increase* (III 31); *457*
upayoga *use* X 27
upari *upper* X 17, 26; upara I 10, IV 7, V 5, VII ⟨1⟩, 2, 3, 8, 10, X 17; *48, 51*
uparima *upper* I 3, X 17, 25

upādā	*to receive* upādīyate II 8F
upānta?	*ninety* uvānta (I 4); *51*
ubhaya	*both* III 8
uraga	*a snake* X 15
uvānta	*ninety* (I 4) (= upānta?)
uṣṭra	*a camel* ū⟨ṣṭhra⟩ III 5; ūṣṭhra III 5; ūṣṭhrī III 5
ūna[1]	*minus* II 4, 5, III ⟨12⟩, 17, ⟨VI 6⟩, VII 3, 6, IX 2; ūṇa II 4F, III 8, 9, ⟨13⟩, 14, 17, IV 4, VII 5, ⟨8, 10⟩, VIII 7, ⟨8⟩; ūnaka X 12; *90, 434, 439, 457*
ūna[2]	*impurity of gold* III 36
ūnita	*minus* ⟨II 6, III 17⟩; *457*
ūrdha	*See* ūrdhva.
ūrdhva	*upper* ūrdha I 10, VII 4, IX 1, 4, X ⟨5⟩, 10, 16, ⟨18⟩, 26; *51, 60, 458*
ūṣṭhra	*See* uṣṭra.
ṛṇa	*debt, negative quantity* VIII 9; riṇa II 1, 7F, III 4, 32, IV 10, 11, VIII 9, 10; *88, 89*
eka[1]	*one* I 1, ⟨2⟩, 8, (11), 12, 13, 15, III 5, 6, 7, (14), 15, 16, (17), 18, 20, 32, 33, 34, (35), 36, IV (2), 4, 6, V 1, 2, 4, 5, 6, VI 1, 2, VII 1, 7, VIII 4, X 2, 9, 11, 15, 16, 18, 19, 21, (22), ⟨23⟩, 24, 25, 25F, 26; aika II 6, III 5, 16, VI 3; meka III 18?, VIII 5, X 15; *45, 51, 52*
eka[2]	*the total, sum* V 1; *53, 92, 457*
ekatra[1]	*in one place* ⟨I 3⟩, III 36, IV 9
ekatra[2]	*the total, sum* ⟨I 3⟩, IV 8, 9, 10; ekattra I (1), 2, 4, 5, II 7, (III 29), X 25; *48, 53, 92, 457*
ekatva	*the total, sum* VIII 2; *53, 457*
ekapañcāśat	*fifty-one* ekapaṃcāśa X 17; *47*
ekapañcāśat-tama	*the fifty-first* ekapaṃcāśama (VIII 3)
ekaviṃśati	*twenty-one* II 4, X 6; ekaviṃśa VII 13; *46*
ekaviṃśati-tama	*the twenty-first* ekaviṃśatima ⟨III 16⟩
ekādaśa	*the eleventh* ekādaśama III 7
ekādaśa(n)	*eleven* III 36, X 13; *46*
ekāśīti	*eighty* III 30
ekonacatvā-riṃśat	*thirty-nine* ekonacatvāriṃśa II 5; *47*
ekonatriṃśat	*twenty-nine* ekonatṛṃśa (VII 13); *46*
ekonaviṃśati	*nineteen* III 17, VI 2
ekonaviṃśati-tama	*the nineteenth* ekonaviṃśatima (III 13), VIII 3

etad	*this* II 4, III 4, ⟨12⟩, 25, 29, ⟨32⟩, VI 1, ⟨VII 9, 10, VIII 3, 9, 10⟩, IX 1, X 10, 19; eta (= etad) I 3, II 3, 4F, 5, III 28, VI 1; etatra (= etasmin?) X 2; etām ⟨X 22⟩; ete I 1F, 3, III 5, VIII 5; etaiḥ II 5, III 16; eteṣāṃ (III 5); eśa (= eṣaḥ *or* etad) I 2F, 9, III 1, 10, 11, 22, 23, 27, 29, 33, 34, IV 10, V 6, VI 4, VII 7, 13, VIII 7; eṣa (= eṣaḥ *or* etad) I 8, II 1F, 5, 6, ⟨7⟩, 8, ⟨9⟩, 10, III 2, 3, 4, 5, 7, 8, 9, ⟨12⟩, 14, ⟨16⟩, 18, 24, ⟨25, 30⟩, IV 5, 6, V (1), 4, 5, 6, VI 4, VII ⟨1⟩, (2), 5, 7, 8, 9, VIII 2, (3), 7, 8, ⟨9⟩, 10, IX 1, X ⟨7⟩, 11, 13, 16, 21, 23, 25; eṣā IX 2, 3; ehu (= etad) VII 11; *44, 54*
etāvat	*this much* III 27
eva	*only* I 8, 17, II 3, 7, 9, III (1), 6, 7, 8, (17), 19, ⟨21⟩, 22, 26, 31, 32, 35, IV 4, 5, 6, 7, 9, 11, V 3, 5, 6, VII (1, 10), 13, VIII 2, 7, 8, 9, IX 3, X 3, 5, 11, 13, 22, 27
evam	*thus* I ⟨3⟩, (5F), II 5, ⟨9⟩, 10, III 1, 3, 6, 7, 20, 23, 24, (27), 31, 34, IV 4, (5, 6), 11, V 4, VI 3, IX 4, X 8, 9, 13; *92*
-ka[1]	*a suffix at the end of a compound* I 4, III 9, 10, 12, 25, 28, 36, IX 2, X 3
-ka[2]	*a suffix for ordinals* III 28, 31, VI 2; *47*
kaṭi/kaṭī	*alloy, mixture?* III 15; *51. See* kṛti[2].
kaṇḍola	*a basket* (IX 2)
kati	*how many, how much* III 17, 35, VII 3F, X 7, 18, 19
kath	*to speak, tell* katthyatā (= kathyatām) V 5; katthyatām (= kathyatām) III 11, 25, 28, 34, VI 1, VIII 4, 6, 9; kathatām (= kathyatām) III 21; kathaya (X 10); kathayasva (X 14); kathayet (IV 1F?), VIII 8; kathyatām ⟨I 2, III 14, VIII 7, X 7⟩
katham	*how* IV 6, X 24
kanaka	*gold* III 32, 33, (34), 36
karaṇa	*doing, computation, calculation* (I 17), II 4, 8, 10, III 8, 9, ⟨10⟩, 11, ⟨13⟩, 14, ⟨15, 16⟩, 17, 19, 21, 24, 27, 28, 29, 30, ⟨31⟩, 32, 33, 35, 36, IV 1, 4, 9, ⟨10⟩, (11), V 2, 5, VI ⟨1⟩, 2, 4, VII 1, 11, VIII 2, 3, ⟨4⟩, 5, 6, ⟨7⟩, (8), ⟨9⟩, IX 3, X 19, 25; karara III 9; *78, 84, 92, 142, 439*
karaṇi	*the square of a number* VII ⟨4⟩, 9, 10; *60–64, 459*
karaṇī	*the square-root* III 12, VII 1; *60–64, 71, 142, 434, 459*
kartavya	*to be made* II 1, III (33), ⟨34⟩, 7, 22, V 6, VII 4, VIII 2, 8
karman	*work* karma III 15, V 5; *43, 404*
kalana	*causing* X 26
kalā[1]	*a part* III 30, (X 11); karā III 33; *309*
kalā[2]	*a unit of weight* X 2, (11), 13, 20; ka⟨lā⟩ X 1, 2, 3, 5, 12; kal⟨ā⟩ X 2; *121, 122, 125, 126, Table 12.14*
kavi	*a poet* IV 1F?
kāṃsya	*bell-metal* I 18
kākiṇī	*a monetary unit* kākinī X 11; *118, 119, Tables 12.11, 12.12*
kāñcana	*gold* kāṃcana III 35
kāṇḍa	*a section, stem* V 6; *401*
kāmika	*an optional number* IV 5, 6; *397*
kāraṇa	*cause* I 10, II 2, X 27
kārya	*to be made* III 6, V 6, (VII 10), X (17), 19
kāla	*time* I 8, 17, III 6, 7, 8, (9), 11, 14, 15, 18, VIII 3, 4, 5, IX 1, 3, X 6, 8, (12), 19
kiñcid	*something, someone* kacid (= kañcid) X 2; kaści (= kaścid) III 15, 29, X 8; kaścid II 7, (VIII 10), X 13, 23; kasyacid (III 26); keci (= kecid) VIII 5; *45*

kim *what* I ⟨1, 2, 4⟩, 7, 14, 14F, II ⟨5⟩, 7, 9, III 16, 18, 19, 20, 21, 24, 25, 26, 28, 30, ⟨31⟩, 33, IV 2, 4, 5, 6, 7, 8, 9, V 1, 5, 6, VI ⟨1⟩, 2, ⟨VII 1⟩, VIII 3, 7, ⟨8⟩, 10, X 1, 2, 4, 5, 6, 11, 13, 15, 16, ⟨18⟩, 19, 20, ⟨21⟩, 24, 25; ka (= kaḥ) V 6; kaḥ VIII 2, ⟨7⟩, 8, IX 1, 3; kasmāt II 2; kā III 26, (30), VIII 6; kāṃ (= kā) (III 28); kena III 7, 8, 11, 14, 15, VIII 4, 5, 9, X (6), 8, ⟨12⟩; kai (= kaiḥ) (III 7), X 10; kaiḥ ⟨IV 1, X 12⟩; *45*

kiyat *how much* III 1, ⟨16⟩, X 9; kiyatā ⟨I 15⟩

kila *indeed, it is said* II 4, III 1, 36, X 6, 13

kīcakanighna *a proper name* (X 22?); *135, 460*

kīṭa *a worm* X 6, (12)

kuṅkuma *saffron* kuṃkuma III 24, 25; *140*

kuḍava *a unit of weight* III 23, 24, (X 14); ku⟨ḍava⟩ III 23, 26, X 14; *116, 117, 121–123, 125, 127, 130, Tables 12.13, 12.15*

kumāra *a boy* X 23

kuśala *versed in* X 15

kṛ *to make* kartum X 27; kāraye (= kārayet) IV 7; kārayet IV ⟨4⟩, 5, V 5, VI 3; kuru V 2, (VIII 2), X 26; kurute III 15; kuryā (= kuryāt) III 1, 4; kuryāt ⟨III 1⟩; kṛtvā (I 13), II 6, III ⟨15⟩, 17, 19, 20, 21, 23, 24, 27, 28, 30, 31, IV 1, 4, 6, 7, V 1, VII (3), 9, VIII ⟨3⟩, 9, ⟨10⟩; kṛyate (= kriyate) I 3, (8), 9, 11, 15, (18), III 2, 3, 4, 8, 12, 13, 15, 16, 19, ⟨20⟩, 22, ⟨25, 26⟩, 30, 32, ⟨34⟩, IV 2, 2F, (5), V 2, 5, ⟨VI 3⟩, (VII 12), VIII 7, (IX 1), X 5, ⟨8⟩, 10, (12), 17, (18), 24

kṛta *made* I 1, ⟨2, 3⟩, (8), II 2, (10), III 1, 4, 5, (12), ⟨21⟩, (22), 30, 33, ⟨IV 3, 6⟩, V 1, 2, VII (3), 6, 7, ⟨9⟩, VIII ⟨5⟩, 9, 10, X 24

kṛti[1] *the square of a number* ⟨III 12, 13⟩, VII 3, 6, 7; *61, 107, 431–434, 459*

kṛti[2]? *product* kaṭi/kaṭī III 35, (V 6)

kṛpaṇa *mean, poor* X 7

kevala *only* III ⟨19⟩, 28, 35

koṭi *a numeral meaning* 10^7 X 15; koṭṭi X 10; *47, 64–66, Tables 6.2–6.7*

kovida *an expert* (X 10)

krama *order, sequence* ⟨I 8⟩, III 22, 34, IV 5, 6, 8, VI 1, 2, X 26; *82, 397*

kraya *buying* VIII 6, 7, 8, 9

kriyā *doing, activity* kṛyā III 19, V 6, (X 17)

krī *to buy* kṛṇāti (= krīṇāti) VIII 6; kṝte (= krīṇīte?) VIII 10; krīṇāti VIII 7; krītvā X 2; krīyate (V 6); *49*

krīta *bought* II 4, III 21

krośa *a unit of length* kro⟨śa⟩ X 11; *114, 116, Table 12.8*

kṣaya[1] *loss* I 9F?, III (12), 19, 20, 21, 22, 23, 24, 26, 27, 28, (29), 30, ⟨31⟩, 32, 34, VII 3, 6, 7, VIII 9, ⟨10⟩, X 1, 20; kṣa⟨ya⟩ III 29; *88, 107, 431, 432, 434, 457*

kṣaya[2] *impurity of gold* III 32, 33, 34, 35; *382*

kṣi *to diminish* kṣīyate III 20

kṣipta *thrown, added* I 9F, III 1, VI 4; *457*

kṣīra *milk* (II 1?)

kṣetra *a geometric figure* V 5

kṣepa *an additive term* III 9, 10, 12, IV 6, V 1, 3; *90, 369, 457*

khaga *a bird* X 13; kha⟨ga⟩ X 13

khārī *a unit of weight* ⟨X 13⟩; khā⟨rī⟩ X 13; *116, 117, 121, 123, Table 12.13*

gagana	*the sky* X 9
gaja	*an elephant* X 22.23; ga⟨ja⟩ X 23; *134*
gaṇ	*to count, calculate* gaṇayitvā VII 5
gaṇa[1]	*a flock* VII 11; *54*
gaṇa[2]	*a division of an army* ⟨X 23⟩; *428, 455*
gaṇaka	*a calculator, mathematician* III (11, 14), 25, 34, (VI 2), VIII 8, X (10), 15, (16), 27; *462*
gaṇita[1]	*mathematics* (III 30), IV 5, 6, X 26, 27; *142, 143, 397*
gaṇita[2]	*the sum of a finite series* VII 1, 6, ⟨10⟩; ga⟨ṇita⟩ ⟨VII 1⟩
gaṇḍikā	*alloy, mixture* III 36; gaṇḍika X 35; *53*
gata	*gone* I 7, 17, III 1, ⟨6⟩, 7, 8, 11, (26), 32, X 1
gati	*path, way* I 17, III (6), 7, 8, 11, (13), X 16
gantavya	*to be traveled* III 16, 18; gaṃtavya III 16
gantu	*a way* gaṃtu III 6
gandhita	*adorned* X 10?
gam	*to go* gacchati III ⟨16⟩, 21, X 8, 12; gacche (= gacchet) X 8, 15; gatvā III 23; gamyate III 11
gamana	*going, journey* III 9, 10, 11, 16
gavyūti	*a unit of length* gadyūti III 23; *51, 114–116, Table 12.8*
gāmin	*going* X 9
gu⟨?⟩	*a measure* X 7; *131*
guñjā	*a unit of weight* guṃ⟨jā⟩ X 21; *117, 121, 125–127, 129–131, Table 12.14*
guḍa	*molasses* III 25, 27
guṇ	*to multiply* guṇaye (= guṇayet) I 10, (12), 14, 17, II 9, III 30, IV 6, 7, VIII 6, 7, 8, X 17, 25, 26; guṇayet VII (4), 9, VIII 7, 8
guṇa[1]	*a quality* (III 29), V 1?
guṇa[2]	*multiplication* I 8?, III 23, IV 5, 7, V 1?, 2; *458*
guṇa[3]	*multiplier, multiplied by* I ⟨3⟩, 4, 7, 13, 14, (15), II 3, 4, 5, 7, III 1, 8, 9, 10, ⟨11⟩, 12, 15, 17, 18, 20, IV 4, 5, 7, 8, 9, 10, 11, V 1?, 3, VI 4; VII 1, 5, 7, VIII 4, ⟨5⟩, X 1, 11, ⟨22⟩, 23; una I 3; gu⟨ṇa⟩ IV 9?, ⟨VI 4?⟩, X 12?, 23?; gu⟨ṇaka⟩ ⟨VI 4?⟩; *51, 87, 88, 90, 91, 458*
guṇana	*multiplication* III (19), 23, (IV 7); guṇaṇa IV 7; *458*
guṇakāra	*a multiplier* guṇākāra I 10, X 25; *458*
guṇita	*multiplied* I (10), 14, II 5, ⟨6⟩, III 5, 7, 10, 12, 13, 17, 18, 20, 21, (23), 24, 25, 27, 28, 29, 30, 31, IV ⟨1⟩, 5, 6, 8, 9, 10, 11, V (1), 4, 6, VII 2, ⟨5⟩, (8), 9, VIII 3, ⟨5⟩, 7, ⟨8⟩, 9, IX 3, X 1, 3, 11, 20, 23, 25; gu⟨ṇita⟩ IV 9?, X 12?, 23?; *87, 88, 91, 93, 458*
guṇitavya	*to be multiplied* VII 3; *458*
guru	*a spiritual teacher* X 7
gulma	*a division of an army* ⟨X 23⟩; *134, 428, 455*
gṛdhra	*greedy* gṛddhra X 14
gṛha	*a house* II 1F
gṛhīta	*taken, seized* (I 12), VIII 9
go	*a cow* II 6, VIII 2; gā⟨vaḥ/vī⟩ II 5; gāvī VIII 3; *42, 51*
godhūma	*wheat* go⟨dhūma⟩ III 6
graha	*a planet* X 16

gha⟨?⟩	*a measure* (? *cf.* ghaṭikā) X 7
ghaṭa	*a pot* V 2
ghaṭaka^{1}	*a pitcher* III 31
ghaṭaka^{2}	*a unit of weight* gha⟨ṭaka⟩ X 8; *122, 125, 126, 129, Tables 12.14, 12.15*
ghaṭikā	*a unit of time* I 18, X 15; gha⟨ṭikā⟩ I 18, ⟨III 13⟩, X 15; *40, 109–111, 149, Tables 12.1, 12.3, 12.7*
ghātita	*multiplied* III 30, ⟨31⟩; *458*
ghoṭa	*a horse* gora VII 11; *54*
-ghna	*multiplied* III (1), 13, ⟨35⟩, VII 1, ⟨5⟩, 6, 8, 10; ghana VII 1; *51, 458*
ca	*and* I 1, 8, II 4, 4F, 7, 9, III 5, 6, 7, 8, 9, 10, ⟨17⟩, 20, 24, 28, 29, 30, 34, 35, 36, IV 4, 5, 6, 7, ⟨8, 9⟩, V 3, 5, 6, VI 2, VII ⟨9⟩, 13, VIII 2, 5, 6, 7, 8, 9, IX 2, X 1, 2, 4, 7, 8, 10, 11, 12, 13, ⟨15⟩, 21, 22, 26, 27; cai II 4
cakṣ	*to tell* cakṣva III 27
catur	*four* I 15, II 5, III (1), 2, 21, ⟨23⟩, 24, 25, 27, 28, (30), 32, 33, ⟨34⟩, 35, 36, IV 4, 7, (8), 9, 11, V 2, VI 2, 4, VII 8, VIII 8, X 14; ca (= catur) III 24; catasra ⟨I 1⟩, X 22; catu (= catur) III 23, 24, VIII 9; catup (= catuṣ in 'catuppaṇe') VII 11; catvāra III 24, (35); catvāri (I 7), IV 7, X 2, 24; canvāri (= catvāri) I 7; cāri (= catvāri) I 7; *46, 54*
caturaśīti	*eighty-four* caurāśīti I 3; caturāśīti VIII 7, X 8; *47*
caturtha	*the fourth* III 2, 3, 22, 31, IV 4, 6, 7, 8, 9, 11, V 3, VI 2; ca⟨turtha⟩ VI 3
caturdaśa	*the fourteenth* caturdaśama III 6
caturdaśa(n)	*fourteen* II 5, V 3, VI 1, X 10, (11); *46*
caturviṃśati	*twenty-four* VIII 7
caturviṃśati-tama	*the twenty-fourth* caturviṃśatima ⟨III 19⟩
catuścatvā-riṃśat	*forty-four* catuścatvāliṃśa (IV 7), VII 13; *47*
catuṣṣaṣṭi	*sixty-four* catuṣṣaṣṭhi VII 13, VIII 10; catusaṣṭhi V 6; *47*
catuḥpañcā-śattama	*the fifty-fourth* caupaṃcāśama VIII 7
catvāriṃśat	*forty* catvāriṃśa III 27, VII 1; catvāriṅśa VII 2; cāliṃśa II 9; *47*
candra	*the moon* X 9
camū	*a division of an army* X 23; *134, 428, 455*
caya^{1}	*a mound?* IX 2
caya^{2}	*the common difference of an arithmetical progression* III 8, 9, VII 1, 6, ⟨8⟩; *457*
carman	*skin* X 7, 9; *43*
caṣaka	*a unit of time* ca⟨ṣaka⟩ III 13; *109–111, 144, Tables 12.1, 12.3, 12.7*
cārcara	*recitation* IX 2
citrita	*striped* cittṛta (X 14)
ced	*if* IV 6; ce VI 1, 2
chajaka	*a proper name* X 27; *85, 86, 461*
chanda	*wish, will* X 9
chid	*to cut, remove* chindhi (= chinddhi) III 5
cheda^{1}	*division* (III 21), IV 12, X 24, 25; tseda II 9; *51, 458*

cheda[2] *a divisor, factor* I ⟨3⟩, 10, III 1, ⟨2⟩, 4, 12, ⟨13⟩, V 6, VII 3, 5, 6, ⟨9⟩, IX 1, ⟨2⟩, 4, X 5, 8, 10, 11, ⟨12⟩, 13, 16, 17, (17F), ⟨18⟩, 18F, (20), ⟨21⟩; che⟨da⟩ X 1, 5, 6, 7, 8, 9, 10, (13), 14, 15, ⟨16⟩, 20, 21, 22; *60, 87, 88, 434, 458*
chedita *divided* (III 34); *458*

-ja *born from* IV 4, X 16
jana *people* II 7, (VII 12); jaṇa VII 11; *54*
janaka *producing* (X 5?)
janman *birth* III 17
jala *water* III 24
jalp *to speak* japa (= jalpa) X 9; *49*
jāta *born, produced* I ⟨4⟩, 5, 7, 8, 9, 14, II 1, 1F, ⟨2⟩, 5, 6, ⟨7⟩, 8, 9, III ⟨1⟩, 2, ⟨3⟩, 4, 5, 6, 8, (9), 10, ⟨11⟩, 12, 13, 14, (15), 16, 17, 18, 19, 20, 21, 23, 24, 25, (26), 27, 28, 29, 30, 31, 32, 33, 34, 35, IV 3, 5, 6, 7, 8, 9, 10, 11, V 1, 2, 4, 6, VI 3, 4, VII 2, 4, 6, 7, 9, 10, 12, VIII ⟨3⟩, 4, 5, 6, 7, ⟨8, 9⟩, X 1, 20, (23), 24, 25; *92, 93*
jāti *a class, category* II 10, III 19; *141, 144, 374, 376, 377, 428*
jīvaloka *the means of livelihood* IV 2, X 19; *53*
jīvyā *the means of livelihood* I 9, X 18, 19
-jña *knowing* III 28, 30, X 16, ⟨22⟩
jñā *to know* jānāmi IV ⟨6⟩, 8; jñātum X 13; jñāyate II 4, III 26, 28, 30
jñāta *known* II ⟨15⟩, 27, (36); jāta IV 9
jñeya *to be known* III ⟨14⟩, (16), 18

ṭala *a unit of capacity or weight* V 6; *51, 116*
ṭalla = ṭala V 6; *117, 404*
ṭallikā = ṭala V 6

ḍhe⟨?⟩ *a unit of weight* I 11; *123, 131*

taṇḍula *unhusked rice* taṃḍula I 3, (11); taṃ⟨ḍula⟩ I 3, 10
tatas *from it, therefore* ⟨I 1⟩, III 5, 19, 32, 33, IV 7; tata III 1, 26, 35, V 2; tato III 2
tatti? *so much, so many?* V 5; *51, 322*
tatra *there* I 17, II 1, 5, ⟨6, 7⟩, 8, III 1, 2, 10, 11, 12, 13, 15, 16, (17), ⟨20⟩, 23, ⟨26⟩, ⟨V 3⟩, VI 1, 2, 4, VII (1), ⟨3⟩, 5, (6), ⟨8, 9⟩, VIII 3, 5, 6, ⟨7⟩, 8, X 2, ⟨5⟩, (24)
tatva *truth, reality* VIII 10, X 13
tatvajña *one who knows truth* III 28, X 16; *462*
tathā *thus, just so* ⟨II 1⟩, III 3, 17, 23, 26, ⟨34⟩, IV 1, V 5, VIII 10, X ⟨1⟩, 4, 12, 13
tad[1] *it* I 4, 8, II 2, 3, ⟨5⟩, 9, III 1, 4, 6, 9, 10, 12, 17, 18, 26, 27, 29, 32, 33, 35, 36, IV 7, ⟨8⟩, 9, 11, V ⟨5⟩, 6, VI 1, 2, VII 1, 3, 5, 6, 7 VIII 4, (10), X ⟨7⟩, 9, 17, ⟨22⟩, ⟨27⟩; ud (*error for* tad) II 4; ta (= tad) I 7, ⟨II 4, III 17⟩, IV 4, VIII 4, X 8, 14, ⟨15⟩, 22; tayor II 1, 2; tasthāt (= tasmāt) VII 3; tasnāt (= tasmāt) VII 6; tasmāt (I 11), VI 4; tasya I 7, III 7, (18), ⟨21⟩, (IV 9), V 2, 3, 5, VII 4, VIII (2), 3, 9, X 7, (13); tasyaṃ (= tasyāḥ) X 11; tāṇi (= tāni) (I 1); tāni (III 35), X 14; te ⟨I 1⟩, II 9, III 17, 34, X 7; tena III 6, 13, 30, X 22; teṣāṃ IV 1; śa (= saḥ) II 7, III 1; śā (= saḥ?) X 6; sa (= saḥ) I 15, III 4, ⟨17⟩, 32, 35, IV ⟨1⟩, 6, VIII 8, ⟨IX 3⟩, X 15; ṣā III 29, VIII 2, 3, 8, X 9, 12; so VIII 2; *43–44*
tad[2] *then, in that case* II 5, III 17, X 15, 18, 19; ta III 7, V 6, X 2, 18, 21

tadā	*then, at that time* ⟨I 15⟩, III 8, ⟨16⟩, 18, 20, 21, 23, 33, IV ⟨4⟩, 5, 6, ⟨8⟩, 9, VIII 7, X (4), 27; *94*
taras	*speed* X 8
tala	*surface* X 10
-tas	*a suffix for the ablative sense* II 1F, 5, ⟨7⟩, III 7, ⟨14, 15⟩, V 5, ⟨VII 4⟩, VIII 10; -ta X 13; -to VIII 10; *49*
tāmbūla	*the areca-nut* tā⟨mbūla⟩ III 6
tāvat	*so much* III 6; tāva I 10, X 19
tu	*but* I 2, 4, 15, 17, II 4, II 5⟨15⟩, 20, 24, 25, 26, 36, IV ⟨4⟩, 5, 6, 7, 9, V 1, 3, VI 2, VII 1, ⟨3⟩, 5, 6, 7, ⟨9⟩, VIII 3, 9, IX 3, X 9, 10, 13, ⟨15, 22⟩, 23, 24, ⟨25⟩, 26
turaga	*a horse* ⟨X 22⟩; tu⟨raga⟩ X 23; *134*
turīyaka	*a fourth part* II 9
tulita	*weighed* I 1, X 11
tulya	*equal* III 27, V 2
tṛ⟨?⟩	= tṛtīya *or a measure* X 17; *131*
tṛtīya	*the third* (I 2, 3), II (3), 4, III 2, 3, (5), 19, 31, IV (1), 2, (7), ⟨8⟩, 9, (10), 11, V 2, 3, VI 1, 2, X 5; tṛ⟨tīya⟩ VI 3, X 17?; tṛtīyaka (IV 4)
tola	*a unit of weight* I 1, 1F, X 1, 13, (20), 21; to⟨la⟩ I 1, III ⟨21⟩, 22, X 1, 2, 3, 4, ⟨13⟩, 20, 21; tolaka X (2), 4; *117, 121, 122, 125, 126–129, Tables 12.14, 12.15*
tyakta	*thrown away* X 9
trapusa	*tin* X 26
traya	*three* ⟨II 5⟩, III (3), 20, 31, IV ⟨4⟩, 7, V 1, (3), IX 2, X ⟨12, 17⟩, (26)
trayastriṃśat	*thirty-three* trayantṛṃśa IX 3; *47*
trayodaśa	*the thirteenth* trayodaśama ⟨III 6⟩
trayodaśa(n)	*thirteen* IX 2, X 5, 24, (25F); trayandaśa I 1; trayodaṣa VI 1; *46*
tri	*three* II 4F, 5, III ⟨5⟩, 20, ⟨32, 34⟩, 35, VIII 7, X ⟨22⟩, 23; trīṇi ⟨I 1, 7⟩, III 11, IV 7, 12, IX 2, X 19, ⟨23⟩, (24); tisra I 1, X 23; tṛ (= tri) I 4, 15, II 4, 5, III 1, 2, 3, 8, 19, 20, 21, 25, 26, 27, 28, 31, 32, 33, 36, IV 1, 5, 8, 9, 11, V 5, VI 4, VIII 3, 4, 6, 7, 8, IX 2, 3, X 8, 10, 11, 12; tre (= tri?) IV 12; trai (= tri) VII 11; tṛka (IV 12); trika III 8; *46, 54, 397*
triṃśat	*thirty* tṛṅśa I 4, VIII 3, ⟨X 16, 19⟩; tṛṅśat X 19; *46*
tritaya	*three* tṛtaya III 15
tripañcāśat	*fifty-three* tṛpaṃcāśa VII 13; *47*
tripañcāśat-tama	*the fifty-third* tṛpaṃcāśama VIII 6
trairāśika	*the rule of three* I (3), 8, 9, (16), 17, ⟨18⟩, II ⟨3, 5⟩, (6), 9, III 7, (11), 13, (14), ⟨16⟩, (18, 20), 21, 31, (33, 34), (IV 3, V 4), VIII ⟨4⟩, (5, 6, 7), ⟨8⟩, 10, IX 4, X 25; *375, 413, 421–429, 438, 439*
tryaśīti	*eighty-three* tṛrāśīti VII 13; *47*
tvad	*you* tvayā ⟨III 5⟩
-da	*giving* VIII 2; *333*
dagdha	*burned* ⟨III 21⟩; dandha III 19; *52*
datta	*given* I 7, 8, 9, III 6, 14, 19, 25, IV (1), ⟨2⟩, 4, 5, 6, 7, 8, 9, VII 12, VIII 4, 5, 6, X 17; data X 21
datya	= dātva *or* dātya? *a share-holder* I 4, 9; *51*
damana	*taming* (X 23)

dala	*half* III 12, 16, IV 12, VII 3, 6, VIII 2, X 22; *432, 434, 458*
dalita	*halved* III 13, VII 5, 8, 10; *458*
daśa(n)	*ten* ⟨I 3⟩, III 5, 16, (17), 25, V 1, 3, VIII 5, ⟨6⟩, 10, X 9, 11, 23; daṣa III 15, 20; daśaka V 5, ⟨IX 2⟩
daśama	*the tenth* III 1
dā	*to give* dattavāṃ (= dattavān) X 13; dattavān II 4, III 30, IV 4, (VIII 5); datvā (= dattvā) III (6), 9, 10, 12, 24, IV 8, 9, 11, (V 5), VIII 4, X 13; dadāti III 12; dadāmi X 2; dade II 7; dadau I 2, ⟨IV 1⟩; dadyā (dadyāt) III 29, IX 2; dadyāt X 11; dāpaye (= dāpayet) X 17; dāpayet (X 17); dīyate (II 5), IV 10; *50, 457, 458*
dāna	*a gift, donation* II 7
dina	*a day* I 8, 9, 17, 18, III 7, 9, 10, 11, ⟨15⟩, IV 1, ⟨2F⟩, VII 3F, VIII 4, IX 2, 3, 4, X 5, 6, 10, 12, 13, 18, 19, 21; di⟨na⟩ I 17, III 7, ⟨13⟩, 14, 18, IV 1, 2, (2F), 3, VIII 3, 4, IX 1, 2, 3, X 6, 8, 10, 12, 13, ⟨16, 18⟩, 19, 20, 21, 24F?; *89, 109, Tables 12.1, 12.7*
divardha	*one and a half* (*cf.* adhyardha) I 14, III 21, IV 8, 9, X 4, 26; divardhaka VIII 5; *47, 52, 91*
divasa	*a day* (VIII 4), X 1, 6, ⟨15⟩, (25); di⟨vasa⟩ X 1; *89*
divākara	*the sun* X 15
dīnāra	*a monetary unit* (I 2), II 4, IV 2, VIII 3, 5, X 2; dī⟨nāra⟩ II 5, IV 2, ⟨2F⟩, 3, VIII 3, X 2, 7; dīnāraka X 7; *118–120* (dīnnāra), *119, 125, 139*
duḥkha	*difficulty* X 7
dṛś	*to see* dṛṣṭhvā (= dṛṣṭvā) III 35, V 3; dṛṣyate (= dṛśyate) III 28
dṛśya	*to be seen, visible* ⟨I 1, II 5, 6⟩, IV (7), 8, 9, 11, ⟨VIII 3⟩; dṛ⟨śya⟩ I 4, II 1, ⟨7⟩, (8), IV 1, 2, ⟨5⟩, 6, 7, 9, 10, 11, V 1, VIII 3; dṛṣya I 3, 4, II 8, IV 1, 4, 5, 6, 8, 9, 10, VII 12; driṣya VIII 3; *94, 95*
dṛṣṭa	*seen* ⟨V 3⟩; dṛṣṭha V 3
deya	*to be given* III 5
devī	*a goddess* X 2
deśa	*place* I 5?, X 11
dra⟨?⟩	= dra⟨kṣūṇa⟩ *or* dra⟨ṅkṣaṇa⟩, *a unit of weight* X 5; *121, 125, 126, 129, Tables 12.14, 12.15*
dramma	*a monetary unit* I ⟨9⟩, (15), X 3, ⟨4⟩, 18, 19, 26; draṃ⟨ma⟩ I 5, 9, 10, 15, 16, X 4, 17, (17F), 18, 19; draṃmma X 18; drama X 3; *118, 119, 121, Table 12.10*
dravya	*a substance* V 2, VIII 4, 5
druta	*quick* X 9
droṇa	*a unit of weight* III 25, dro⟨ṇa⟩ III 26; *116, 117, 123, Table 12.13*
dvaya	*two* I 10, II 2, 9, 10, III 8, 14, 26, 34, 35, IV 4, ⟨7⟩, (9), V 5, VII 9, VIII 5, IX 2, X 17, 26
dvācatvā-rimśat	*forty-two* (VIII 10); dvācatvāliṃśa (I 3, VII 13), X 18; *47*
dvātriṃśat	*thirty-two* dvātṛṅśa III 20; *47*
dvādaśa(n)	*twelve* (I 14), V 3, 5, IX 3, X 7, 21; vāraha VII 11; *46, 54*
dvāpañcāśat-tama	*the fifty-second* dvāpaṃcāśama (VIII 4)
dvāviṃśati	*twenty-two* dvāviṃśa IV 8; *46*
dvāṣaṣṭi	*sixty-two* dvāśaṣṭi (VII 13); dvāśaṣṭhi V 6

dvi	*two* I 1, ⟨3⟩, 7, 8, 10, 13, 15, II 3, 4, 5, 7, 8, III ⟨6⟩, 8, 9, 10, ⟨11⟩, 12, 15, 17, 18, 20, 31, 32, 33, ⟨34⟩, 35, 35, IV 4, ⟨8, 9, 11⟩, 12, V 5, VII 1, 3, 5, 6, 7, ⟨8⟩, VIII 2, 3, 4, ⟨5⟩, 6, 7, 10, X 3; du I 3; *45*
dvija	*a man of a twice-born class* IV 4, (7); *462*
dvijanman	= dvija III 17
dvitīya	*second* I (3), 9, (17), II 3, 5, III 1, 2, 3, ⟨5⟩, 7, ⟨8⟩, 11, 14, 15, ⟨18⟩, 19, 22, (31), IV 4, (9, 10), ⟨11⟩, V 2, ⟨3⟩, VI 1, 2, VIII 4, 5, 6; dvi⟨tīya⟩ ⟨I 17⟩, III 7, 9, VI 3; *89*
dvidhā	*in two ways* VII 7
dha⟨?⟩	I 12
dhana^1	*property* I 9, 11, II 1F, 2, 4, 5, 6, 8, III 1, 2, 3, 5, 6, 9, 14, IV 4, 6, (7), 9, V 1, 4, VI 1, 2, 3, 4, VII 1, 8, ⟨10⟩, VIII 2, 4, 5, 6, X 7, 17F; dha⟨na⟩ III 9?; dhaṇa II 5
dhana^2	*a positive number, value* II 1, III 27, VII 1; *71*
dhana^3	*the sum of a mathematical progression* VII 8, ⟨10⟩; dha⟨na⟩ III 9?
dhanus	*a unit of length* X 9; dha⟨nus⟩ X 9; *114, 116, Table 12.8*
dharmajña	*a righteous man* III 30; *462*
dhānta	*See* dhmāta.
dhānya^1	*a unit of weight* thā = dhā⟨ṇa⟩ X 20; dhāṇa X 20, 21; dhā⟨ṇa⟩ X 2?, 3, 5?, ⟨13?⟩, 20, 21; *119, 121, 122, Tables 12.14, 12.15*
dhānya^2	*a monetary unit* dhāṇa X 2; dhā⟨ṇa⟩ X 2, 7; *118, 120, Table 12.9*
dhānyaka^1	= dhānya^1 dhānaka X 2; dhā⟨naka⟩ X 2?, 5?, ⟨13?⟩; *122, Table 12.14*
dhānyaka^2	= dhānya^2 dhānaka X 3; *118, 119, Table 12.10*
dhṛ	*to maintain* dhārayet IX 3
dhmāta	*smelted* dhānta III 19, 20, ⟨21⟩, 23, 28, 30, 31; dhvānta III 19, 29; *52, 374*
na	*not* II 4, III 12, ⟨15⟩, 26, 28, 30, IV 6, 8, 9
nabhas	*the sky* (X 9)
nara	*a man* I 12, II 4, III 6, 11, X 8, 11, ⟨22⟩, 23; na⟨ra⟩ X 23; *134*
nava(n)	*nine* I 10, III 5, 7, (31), 34, IV (2), 8, 9, 11, VIII 3, X 5, 6, 7
navanavati	*ninety-nine* (VII 13)
navama	*the ninth* III 1
nāga	*a snake* X 9
nāman	*a name* X 7, 16, ⟨23⟩
nikṣip	*to put down, add* nikṣipya VII 1, (3), ⟨5⟩, 6, ⟨8⟩; *457*
nitya	*continual, constant* III 14, X 8; nityaśas X 9
nidhṛ	*to lift up* nidhāryate X 9
-nibha	*resembling* X 9
niyata	*constant* III 13, 14, 15
niyuta	*a numeral meaning* 10^5 niyata (X 10); *47, 64–66, Tables 6.1–6.3, 6.5, 6.6*
nirgam	*to go out* nirgacchamāna I 7
nivṛt	*to go backwards* nivartaṃte X 12
niścaya	*certainty* (V 5), X 1
niścita	*ascertained* X (8), 15
nīta	*carried off, reduced to* X 9, 11
nīvi	*capital* VIII 9; nīvī VIII 6, 7
nṛpa	*a king* I 2, (3)
nṛpati	*a king* VIII 5
neya	*to be pulled* niya III 16; *50*

nau	*a ship* X 12
nyas	*to put down* ṇyasya (= nyasya) VI 1; nyasya ⟨VI 1, 2⟩
nyasta	*put down* ṇyasta IV 6
nyāsa	*setting down, statement* II 3, 5, ⟨III 1, 11⟩, IV 5, 9, 10, (11), ⟨VI 1⟩, (VIII 2), X 4, ⟨8⟩, (21); nyāśa X 12; nyāsasthāpana (VII 10), IX 1, X (8), 10; *78, 84, 87, 142*
paṅkti	*a row* paṅti V 2
pañca(n)	*five* ⟨III 34, X 22⟩; paṃca I 3, 7, II 7, 10, III 1, ⟨10⟩, 11, 14, 16, 25, 26, 27, 33, 35, IV (1), ⟨1F, 8⟩, 9, ⟨11⟩, V 1, 2, 5, VI 1, 4, VIII 2, 3, 4, 9, IX 2, X 1, 5, 8, 11, 12, 13, 16, 18; paṃcca X 1; paṃtu I 15; paṅca III 10; *46, 52*
pañcaka	*five, the fifth* paṃcaka III 7, 11, 16, (21), 25, 28, ⟨IV 2⟩, VI 2, 4, VII 5, 7, X ⟨1⟩, 12; *47*
pañcatriṃśat	*thirty-five* paṃcatṛṃśa (X 4)
pañcadaśa	*the fifteenth* paṃcadaśama III 7
pañcadaśa(n)	*fifteen* paṃcadaśa III 34, (V 5), VI 1, X 13, (14)
pañcadhā	*in five ways* paṃcadhā (V 5)
pañcapañcāśat	*fifty-five* paṃcapaṃcāśa X 14; *47*
pañcapañcāśat-tama	*the fifty-fifth* paṃcapaṃcāśama VIII 8
pañcama	*the fifth* paṃcama II 9, 10, III 2, 3, (19), 28, 31, V 3, ⟨VI 2⟩, (X 9); paṃ⟨cama⟩ VI 3
pañcaviṃśati	*fifty-five* paṃcaviṃśa III 7; paṃcaviṅśa (VII 8); *46*
pañcaviṃśati-tama	*the twenty-fifth* paṃcaviṃśatima III 29
pañcaṣaṣṭi	*sixty-five* paṃcaśaṣṭhi I 2, X 10
pañcasaptati	*seventy-five* paṃcasaptati X 11
pañcāśat	*fifty* paṃcāśa III 18, X 6; *47*
pañcāśattama	*the fiftieth* paṃcāśama VIII 2
paṭa	*a garment* VIII 10, X 10; paṭakā VIII 10
paṭu	*skillful* ⟨X 15⟩
paṇa	*a monetary unit* I 12, VII 11, VIII (7), 10; *54, 118, 127 (weight), Tables 12.11, 12.12*
paṇḍita	*a scholar* III 19, 20, (21, 24), 31, ⟨36⟩, VIII 4, ⟨10⟩, IX 3, ⟨X 11⟩; *462*
paṇya	*commodity* I 15, X 26; paṃya X 26; panya X 26; *435*
pat	*to fall, subtract* patamāṇa (= patamāna) X 9; pātayitvā VII 1, ⟨9⟩; *457*
pati	*a lord* VIII 5 (*in* nṛpati)
patita	*fallen* X ⟨9⟩, 10
patti	*the smallest unit of an army* X 22; pati X 23; *134, 428, 455*
patra	*a leaf* III 1, (6), ⟨VIII 3⟩, (IX 2); pattra III 7; *84*
patrin	*one that has wings* (X 7)
pathin	*a path, road* III 8; *43*
pada[1]	*the period of a mathematical progression* III 8, 12, 13, 15, VII ⟨1⟩, 5, 7, 8, 10; pa⟨da⟩ III 8, 9, 11, 14, 15, 17, IV 4, VII ⟨1⟩, 5; *71, 72*
pada[2]	*a quarter* X 12; *71, 72, 458*
pada[3]	*the value of an unknown number?* II 4; *53, 71, 72*
padāti	*a foot soldier* ⟨X 22⟩; *134*
payas	*milk* V 2; pa⟨yas⟩ ⟨V 2⟩; payasa V 2; *52*

para	*other* I (3), 4, ⟨IV 4, VIII 10⟩, IX 2
paramparā	*succession* X 14
paratas	*afterwards* (III 7)
parama	*highest* X 27; parima X 8
paraloka	*the next world* IX 2; pa⟨raloka?⟩ IX 1; *340*
paravaptṛ(ka)	*a landowner* I 4
parāvarta	*turning back* X 9; parā⟨varta⟩ X 9; *135*
parikṣīṇa	*waste* (III 28)
parimāṇa	*quantity, amount* X 9; parīmāṇa X 22
pariyoca	? III 16; *52*
parivartana	*turning round, the reciprocal* III 1, ⟨2⟩, 4, IV ⟨1⟩, (2); *458*
parivṛta	*surrounded* X 15
parimukta	*released* parīmukta (X 10)
pala	*a unit of weight* I 1, 2, III 21, 30, 31, X 1, 20, 21; pa⟨la⟩ X ⟨1⟩, 11, 20, 21; pal⟨a⟩ X 20, 21; *117, 121, 122, 125–130, Tables 12.15, 12.16, Figure 12.1*
pavana	*wind* pavaṇa (X 9)
paścāt	*afterwards* paścā X 27
pā	*to drink* pibet III 23
pāka	*honest* X 19
pāṇḍu	*a proper name* X 16; *460*
pāta	*fall, subtraction* VII 10; *457*
pātavya	*to be kept?* I 8
pātita	*made to fall, made to be subtracted* (III 31), VII ⟨4⟩, 8, (9), 10, ⟨X 9⟩; pāteta VII 7; *50, 457*
pātya	*to be subtracted, removed* I 5, 9, II 5, III (3), 13, (23), 28, IV 10, VII 2, 3, (5), VIII 7, 8, 9, (10); *93, 457*
pāda[1]	*a quarter* (I 2), II 5, 10, III 1, 2, (3), 7, 26, IX 2, X 8, 22; *71, 458*
pāda[2]	*a unit of weight* X 2, 3, 13; pā⟨da⟩ X 1, 2, 3, 5, ⟨8⟩, 12, 20; *121, 122, 125, 126, Table 12.14*
pānīya	*water* V 2
pārāvata	*a pigeon* pārāa VII 11; *54*
pārtha[1]	*a proper name* X 22; *460*
pārtha[2]	*See* prāsta.
pālāhata	*a monetary unit* X 3; pā⟨lāhata⟩ (X 3); *118, 120, Table 12.10*
pāsta	*See* prāsta.
pāstha	*See* prāsta.
piṇḍa	*a ball, the sum, total* ⟨I 1⟩, II ⟨9⟩, 10, III 5, 25, 27, 28, 36, IX ⟨1⟩, 4; pi⟨ṇḍa⟩ II 10; piṇḍatā VIII 7, 8; piṇḍavat VIII 8; *457*
pīta	*drunk* III 24
puṃs	*a man* X 13
putra	*a son* VIII 5, X 27
punar	*again, on the other hand* III 2, 17, ⟨20⟩, 22, ⟨26⟩, VIII 2, 6, ⟨7⟩, X 11, 12, (24); puna I 7, 9, 13, III 2, 15, 21, 24, 25, 26, (30), IV 12, IX 4, X 4, 5, (24)
puruṣa	*a man* II (1F), 2, 5, 6, 7, 8, III 6, V 1, X 18, 19; pu⟨ruṣa⟩ X 19, ⟨21⟩; puruśa (II 2); *393*
pūjā	*worship* IX 2
pūrva	*previous, before* (I 17), II 7 (anupūrvaśas), III 6, 7, ⟨8, 11, 26⟩, (31), VI 3

pṛtanā	*a division of an army* X 23; *428, 455*
pṛthak	*separately* II 4, III (1), 5, V ⟨1⟩, 2, VI 4, VII 1, 2, (5); pṛthaṃ (I 12); *49, 407*
pṛthivī	*the earth* X 8
pṛṣṭa	*questioned* praṣṭa (I 8), VII 11, VIII 2, 3, X 19; *50*
pṛṣṭha	*the back* V 5; *401*
peśī	*a piece of meat* I 1
pautra	*a grandson* X 27
prakalpita	*supposed* V 5
prakāra	*sort, kind* IV 11; *397*
prakriyā	*procedure* prakṛyā X 26
prakṣipta	*thrown, cast, added* IV (5), 9; *92, 457*
prakṣepa	*addition, an additive term, investment, share* I 2F, 4, IV (1, 2, 4), 8, 11, V 1, (2); prakṣipa (IV 5); prakṣepaka III 23, V 2; *389, 396*
prati	*towards, against* III 15, VIII 4; pratigati (= pratidinagati) III 11; pratidina IX 4; pratidine III 11; pratidinena X 6; pratimahni X 2; pratyaham III 14, 15, X 13, (16); pratyeka (III 3), X 25; pratyaika II 6, III 5, VI 3; *52*
pratinihita	*substituted, a substitute* III 9, (10), 12; *369*
pratyaya	*a verification* I (3), 8, (9), ⟨16⟩, 17, (18), II (5), ⟨6⟩, 9, III (1), 7, 8, 9, 11, 13, ⟨14⟩, 16, ⟨18⟩, 19, (20), 21, 22, ⟨23⟩, 25, 26, 27, (30), 31, ⟨33⟩, 34, IV 3, V 4, VIII ⟨4⟩, 5, ⟨6⟩, (7), ⟨8⟩, 9, ⟨10⟩; *72–75, 84, 141, 142, 407*
pratyānayana	*a verification* (VII 5, 7), VIII 2; *72, 73, 84, 142, 407*
prathama	*first* I 9, II 1F, 4, 5, 7, 8, 9, III 2, ⟨3⟩, 19, IV 4, 5, 6, 7, 8, 9, 11, V 1, (2), ⟨3⟩, VI 1, (2, 3), VIII 4, 5, 6, X 25; pra⟨thama⟩ VI 3
pradatta	*given* III 5
pradṛś	*to see* pradṛśyate III 28
prabhava	*the first term of a mathematical series* III 15; *53*
prabhā	*light, splendour* (III 14)
pramāṇa	*quantity, amount* III 36, IV 4, V 6, IX 2, (4), X 11, 13, 21, 22, 23; pramāṇaka ⟨III 34, V 5⟩
prayam	*to give* prayacchati (X 11)
prayā	*to go* prayāsyāt X 15
prayāta	*traversed* X 15
prayukta	*employed?* (X 14)
prayojita	*invested* (III 25)
pravac	*to speak* pravakṣyāmi II 7
pravardhita	*increased* (III 31); *457*
praviś	*to enter* praviśati X 6; praviśamāna I 7
pravṛtti	*the original (first) quantity* III 23, 28, 29, 30; pravṛti III 19; pravṛttikā III 28; *53, 303*
praśna	*a question* ⟨X 25⟩; praṣna II 5, III 17, X 5, 25
prasaṃkhyāna	*counting, the size* ⟨X 23⟩
prasāda	*favour* X 7; *139*
prasṛti	*a unit of weight* X 13; pra⟨sṛti⟩ X 13; *121–123, Table 12.13*
prastāra	*a tabular expression* III 22; *375*
prastuta	*proposed* X 19
prastha	*a unit of weight* III 23, (24); pra⟨stha⟩ III 26; prasthi III 26; *116, 117, 121, 123, 130, Table 12.13*

prājña	*a wise man* III 29; *135, 462*
prāṇin	*a living creature* III 5
prānta	*edge?* I 13
prāp	*to reach, obtain* prāpya X 9, 10; prāpyate VIII 7; *50*
prāpta[1]	*obtained* II 7
prāpta[2]	*pure (gold)* III 35; *53*
prāsta	*cast* pārtha III 19; pāsta III 23, 24, 27; pāstha III 20, 28; *52, 374*
projjh	*to discard, subtract* projjhya III 1, 2, 4; *457*
projjhita	*subtracted* III 33; *457*
phala	*the result of a calculation* I ⟨2⟩, 2F, (3), 4, 8, 9, 10, 14, 14F, 16, 17, 18, II 6, 10, III 8, 9, 11, 13, 14, ⟨16⟩, 17, 19, 20, 21, 22, 25, 26, 27, 29, 30, 34, IV 2F, 3, 4, 12, V 6, VIII 4, 7, 9, 10, IX 1, 4, X 2, ⟨6⟩, 9, (10), 13, 14, (15), 16, 17, ⟨18⟩, 20F, 21, 22, 25, 26; pha⟨la⟩ I ⟨2⟩, 3, 18, II 5, 10, III 7, 14, 18, 20, 31, 33, 34, V 1, 4, VIII 5, 6, 8, X 3, 4, 5, ⟨6⟩, 7, ⟨8⟩, 11, 12, 15, ⟨18⟩, 19, 24, ⟨25⟩; *87, 93–95, 421*
bala	*force* X 12
bahu	*much, many* bāhu X 13
budha	*wise* II 7, VIII 4, 8, X ⟨22⟩, 23; *462*
brahmaloka	Brahman's *World* X 10; *136, 455, 461, Figure 13.1*
brāhmaṇa	*a man of the first cast* III 17, IX 2, X 27; *85, 86, 139*
brū	*to tell* brūhi III 21, IX 3, X 15, 16
bhakta	*divided* I ⟨3⟩, 8, II 10, III ⟨12⟩, (18), 28, (30), ⟨31⟩, IV 1, (8), 9, 11, (VII 7), ⟨VIII 7, X 1, 20⟩; *93, 458*
bhakti?	*a section* bhatti V 2; *51, 322*
bhakṣ	*to eat* bhakṣayet ⟨VIII 3⟩
bhakṣaṇa	*eating* IX 1
bhaj	*to divide* bhaktvā II 2, 9, III 17, 27, 29, 32, 33, 34; bhajet III 15, VIII 6; bhājaye (= bhājayet) VIII 7, 8, 9, X 26; bhājayet III 15, (32); bhājayeta (= bhājayet) III 33; *50, 93, 458*
bhajita	*divided* II 7; *458*
bhaḍila	*a servant* (III 15)
bhaṇḍi?	*wave* bhaḍḍi V 5; *51, 322*
bhaya	*fear* X 9
bhavānī?	*name of a goddess* bha⟨vānī?⟩ IX 1; *143, 340, 460*
bhā	*lustre* III 32
bhāga[1]	*division, a part* I 1F, 10, II 5, 9, 10, III 1, 2, (3), 13, 16, 19, 20, 21, 23, 24, 25, 26, 29, 31, 34, V 1, 3, 4, 5, VII ⟨6, 8⟩, 10, (VIII 5), IX 2, 3, X (1), 5, 6, 8, 9, 11, 12, 14, 25; bhā (< bhāa = bhāga?) III 33; *93, 94, 458*
bhāga[2]	*a degree of arc* X 16; *113, Tables 12.6, 12.7*
bhāgahāra	*division, a divisor* I 11, (15); *87, 88, 90, 376, 432, 458*
bhāgin	*receiving a share, an owner* I 5?
bhājita	*divided* II ⟨1F⟩, 2, 5, 6, (8), III 1, ⟨9, 10⟩, 12, 14, IV 6, VII 3, 9, ⟨VIII 8⟩; bhā⟨jita⟩ I 7, 9, III 19, ⟨20⟩, 21, 22, 25, 26, 30, ⟨31⟩, VII 3, ⟨6⟩, IX 1, 3, X 1, 2, 3, 12, 13, 20, 21; *87, 88, 94, 95, 376, 432, 458*
bhājya	*to be divided* II 1, (1F), 5, ⟨7⟩, (8), VIII 6; *393, 458*

bhāṇḍa	*commodity* IX (1), 3
bhāṇḍāgāra	*a treasury, stock* (VIII 3)
bhāṇḍāra	*a storehouse* IX ⟨1⟩, 3, (4)
bhānu	*the sun* rbhāṇu X 15; *460*
bhānuja	*the planet Jupiter* X 16
bhāra	*a unit of weight* I 13, III 25, X ⟨1⟩, 21; bhā⟨ra⟩ X ⟨1⟩, 11, 21, 24; *121, 125, 127, 130, Table 12.15*
bhukta	*eaten, spent* III 24, X 7, 13
bhukti	*eating, enjoyment* (III 23)
bhuj	*to traverse* bhukte (= bhuṅkte) X 16; *50*
bhuja	*a side of a geometrical figure* bhu⟨ja⟩ IV 12; *417*
bhū[1]	*to be* babhūvā (= babhūva) III 31; bhavati I 8, II 7, 10, III 2, 3, 6, 18, IV 2, (V 6), VII 1, VIII 6, 10, X (19), 24, 25; bhavatu X 27; bhavate III 8; bhavaṃti III 3; bhavanti I 3, (II 6), III 7, 9, 23, IV 11, VIII 5; bhaviṣyati I 17; bhave (= bhavet) III 35; bhavet (I 14), III 1, 8, 25, (29), IV 5, 6, V 5, ⟨6⟩, VIII 3, 6, 8, X 11, 16, 24, (27); bhavetām (= bhavet) II 4; *50*
bhū[2]	*the earth* X 10
bhūta	*five* (*a* bhūtasaṃkhyā) X 1; *91, 143*
bhūmi	*the earth* X 9, 10
bhṛtaka	*a servant* III 15, VIII 4
bheda	*division (by two)* V 5; *458*
bhojana	*eating, enjoyment* IX 2, 3, X 7
bhrānti	*a corruption* III 8
maṇi	*a jewel* III 1, 2, 3, 4, X 14
maṇḍa	*a unit of weight* maṃ⟨ḍa⟩ VII 12; maṃḍa VII 11, 12; maḍa VII 11; maṃḍakā (VII 11); *122, 131*
maṇḍalaka	= maṇḍalikā V 6; *117, 404*
maṇḍalikā	*a unit of capacity or weight* maṇaleā V 6; *52, 116*
matimat	*wise* III 12; *462*
mad	*I* mama III 17, 28, V 5, VI 1, (X 11F, 18); me III 5, (27), 28, 29, (34), VIII 5, X 2, 8, 15
madya	*wine* IX 3
madhu	*honey* III 23, 24, V 2; ma⟨dhu⟩ III 24, V 2; maddhu III 23
madhya	*middle* III 1, X 1
madhyama	*middle* (X 26)
manuṣya	*man* (VII 12), X 19; maḍa (*error for* manu⟨ṣya⟩) VII 12
mandira	*a dwelling place* madira X 8
-maya	*made of* III 27
mala	*dirt, dross* III 19, 21
mahat	*big* X (1), 15, 22, 27
mahātmavat	*a high-minded man* X 22; *462*
mahāśobhana	*having great lustre (gold?)* (X 1)
mahiṣī	*a she-buffaloe* II 6; mahi⟨ṣī⟩ II 6
mahoraga	*the great serpents (a class of semi-divine beings)* X 15; *460*
mākṣika	*honey* III 31
māṇa	*a unit of weight* X 14; *130*

māna	*measurement* V 5; māṇa X 5
mānaka	*a man of pride* VIII 9
mānava	*a man* (III 15)
mārtikāvatī?	*name of a city* ⟨mā?⟩rtikāvati X 27; *149, 150, 461*
māṣa	*a unit of weight (and of money?)* III ⟨33⟩, (34), ⟨35, 36⟩; mā⟨ṣa⟩ X 1, 4, 14; māśa III (22), 33, (36); *116, 120–122, 125–127, 129–131, 382, Tables 12.14, 12.16*
māṣaka	= māṣa III 32, 35, 36; maśaka III 35; māśaka III 15, 33, 34, 35, 36, X 4, 14; *118, 121, 122, 129, 130, Table 12.9*
māsa	*a month* X (1), 13; mā⟨sa⟩ IX 1, X 1, 6, ⟨8⟩, 10, 12, 20; *109, 111, Tables 12.1, 12.3, 12.7*
miśra	*mixture, the sum* V 2, 3, VI 1, 2, VIII 8; miśraka VIII 8; *457*
mukhya	*principal* mūkhya X 2?
mudga	*a kidney bean* I 10, 11
muhūrta	*a unit of time* X 15; mu⟨hūrta⟩ X ⟨6⟩, 15, ⟨18⟩; *109, 111, Tables 12.1, 12.3, 12.5*
mūdṛ	*a unit of weight* X 2; mū⟨dṛ⟩ X ⟨1⟩, 2, ⟨3⟩, 5; mūdṛkā X 2, 3; *52, 121, 122, 125–127, Table 12.14*
mūrdhan	*a head* X 13, 27
mūla[1]	*the original quantity* III 19, 20, ⟨21⟩, 22, 30
mūla[2]	*capital* I 7, II 3, III 26, VI 4, VIII 7, 8, 9, 10
mūla[3]	*the square root* III 9, 10, 12, VII 1, ⟨3⟩, 5, 6, 7, 9, VIII 2; *71, 72, 87, 88, 90, 92, 95, 143, 333, 434, 459, Table 6.8*
mūlya	*price* III 1, 2, 3, 4, 5, 6, V (5), 6, VIII 10, X 2, 4, 14, 25; mū⟨lya⟩ X 2; *429*
meru	*name of a mountain* X 8 (su-); *136, 455, 461*
yaj	*to worship* yajaṃti X 2
yajana	*sacrifice* I 3
yatas	*because* III 5
yati	*an ascetic* X 9; *462*
yatra	*where* V 5
yathā	*as* III 15, 18, V 6
yad	*which, who* I 7, II 4, III 9, 35, 36, VIII 3, 4, 8, 10, X 7; ya (= yad) VIII 8; yaḥ VIII 6, 7; yasya II 4, III 27, 32; yā X 12; *45*
yadā	*when* ⟨III 8⟩, X 4, (27)
yadi	*if* I (4, 15), ⟨II 5⟩, III 16, 18, 20, 29, (30), (V 6), VIII 7, X 16, 18, 19, 21
yadṛcchā	*an optional number* IV 4, 5; *397*
yava[1]	*a unit of weight* X 1, 2, 4, 13; ya⟨va⟩ X 1, 2, 3, 4, 5, ⟨12, 13⟩; *121, 122, 125–127, 129, Tables 12.14, 12.16*
yava[2]	*a unit of length* X 12; ya⟨va⟩ X 12; *114, 115, 144, Table 12.8*
yā	*to go* yāti III 7; yāsyati X 1
yācanā	*begging* III 1
yācita	*begged* (X 21)
yāta	*reduced to a certain state* II 1
yāva	*the square power* VII 3; *61, 81, 82, 142, 459*
yāvat	*as much* III 6; jāma VII 11; *54*
yāvattāvat	*name of an unknown number* yā⟨vattāvat⟩ II 4; *76–82, 89, 149, 394*
yukta[1]	*yoked* III 16
yukta[2]	*summed, added, increased* (I 7), III 33, IV ⟨8⟩, 11, X 17, 24; *457*

yukti[1]	*the sum* III 1, IV (1), ⟨2⟩, 11, V 1, ⟨2⟩; *389, 396, 457*
yukti[2]	*principle* I 2F, (4), IV 4; *389*
yuj	*to yoke, add* yujyate III 16; yojayet (X 17); *457*
yuta	*increased* I (7), 8, ⟨9⟩, 10, 12, 15, ⟨18⟩, II 3, 5, ⟨6⟩, III 1, 2, ⟨3⟩, 6, (10), 12, 13, (27), ⟨31, 33, 34⟩, IV 4, 7, 8, 9, 10, 11, VI 3, VII 8, VIII 2, X 13, 14; yu⟨ta⟩ VIII 2; *87, 88, 90, 92, 95, 457*
yuti	*the sum* II (5), 6, 10, III 4, 32, 33, 34, 35, IV 5, 6, ⟨7⟩, VIII 2; yuta II 7; *92, 397, 457*
yudhiṣṭhira	*a proper name* X 16; *135, 460*
yuvan	*young* yuvī (*a young girl*) VII 12; *52*
yoga	*the sum, addition* II 1, 2, 8, III 2, ⟨5⟩, ⟨IV 3⟩, V 2, 5, ⟨VI 1⟩; *92, 457*
yojana	*a unit of length* I 17, 18, III 6, 7, 10, 11, 13, 16, 18, 23, X 8, ⟨9⟩, 10, 12; yo⟨jana⟩ I 17, 18, III 7, (11), 16, 18, X 8, 10, 12, 15; yoja X 12; yoja⟨na⟩ X 9, 14; *114–116, Table 12.8*
-yojanika	*one who travels so many* yojanas *a day* III (7, 11), 18
yojya	*to be added* VII 1; *457*
rakti	*a unit of weight* X 1, 2, 5, 20; ra⟨kti⟩ X 2, 3, ⟨20⟩; *120, 122, 125–131, Tables 12.14, 12.15*
rakṣaka	*a watcher* rākṣaka X 19
ratha	*a chariot* III 16, (18), X 15, 22, 23; ra⟨tha⟩ X 23; *134*
rasa	*six* (*a* bhūtasaṃkhyā) VIII 4; *91, 143*
rahita	*decreased by, deprived of* III 9, 10, 11, 32, IV 11; *457*
rājan	*a king* II 7, (VIII 5), X 16, 23, 27
rātri	*night* X 15
rāvaṇa	*a proper name* X 9; *135, 136, 460*
rāśi[1]	*quantity* I 2F, II 1, 8, ⟨9⟩, III (9), 10, 36, IV 6, 7, 11, V 2, VI 1, VII 7, VIII 2, 4, 9, IX 1, X 1, (5), 11, 17, 24F, (25), 26; rā⟨śi⟩ X 11, 16; rāṣi II 1, III 10, 12, X 11; rāsi (X 11)
rāśi[2]	*an arc equivalent to 30 degrees* X 15; *113, Tables 12.6, 12.7*
rūḍha	*burdened* III 16
rūpa[1]	*an integer, a coin* I 16, II 2, IV 1, (V 1), VII 7?, VIII 3, (X 24); rū⟨pa⟩ I 16, IV 1, VIII 7; *10, 78*
rūpa[2]	*unity* II 7, III 1, 8, 9, ⟨13⟩, 14, 15, 17, 19, 20, 21, 23, 24, 26, 27, 28, 29, 30, ⟨31⟩, IV 4, 8, 9, 10, 11, VI 4, VII 5, 7?, ⟨8, 10⟩, VIII 6, (7), ⟨8⟩, 9, ⟨10⟩; *91, 143, 439*
rūpoṇākaraṇa	*Minus-One method* III 8, 9, ⟨13⟩, 14, 17, IV 4
rūpaka	*a coin* VIII ⟨4⟩, (9); rū⟨paka⟩ III 14, VIII 4, X ⟨24⟩, 25; *118, 121*
roman	*a hair* X 7
lag	*to arrive at* lagyanti X 19; *49*
lagna	*adhered* III 16
labdha	*obtained, the quotient of a division* (12, 13), II 7, III 5, 10, 12, (13), 14, 15, (16), 17, 18, ⟨20⟩, 23, 29, 31, (32), 34, 35, 36, V 1, VI 4, VII 8, ⟨10⟩, VIII 3, 4, 7, 8, X 14, 24, 26; *93, 458*
labdhi	*gain* V 1
labh	*to obtain* labhati X 24; labhate VIII 8; labhyate VIII 7, X 26; *50*
lavaṇa	*salt* X 11; lavana X 11

lābha	*profit, gains, harvest* III 25, (26), VIII 6, 7, 8, ⟨9⟩
likh	*to write* likhiṣyāmi X 25; *85, 86*
likhita	*written* III 8, X 27; *85, 86, 360*
liptā[1]	*a unit of arc* X 16; lipta X 16; *113, Tables 12.6, 12.7*
liptā[2]	*a unit of time* li⟨ptā⟩ III 13; *109, 112, Tables 12.1, 12.5*
loka	*world* IV 2, IX 2, X ⟨10⟩, 19; *137, 138, Figure 13.1*
loha	*iron, base metal* III 20, 28, 30, ⟨36⟩; *119, 125*
va⟨?⟩	=vā⟨?⟩ *a measure* X 7
vaṃśa	*lineage, family* X 16
vaṃsura	*a troop?* II 9; vaṃ⟨sura⟩ II 9; *52, 456*
vaktavya	*to be told* (X 17)
vac	*to tell* ucyata (= ucyatām) III 6; ucyatām I 4, III 26, 27; ucyatem (= ucyatām) (VII 1); vaktum III 5, X 15; vakṣyāmi (III 32), X 25; *85*
vajara	*See* vajra[2].
vajjara	*See* vajra[2].
vajra[1]	*a diamond* X 14
vajra[2]	*a monetary unit* vajara IX 3; vajjara IX 2, (X 3); va⟨jjara⟩ X 3 vajjaraka (IX 1); *52, 118–120, Table 12.10*
vaṇij	*a merchant* III 1, 3, 5
vaṇijaka	*a merchant* III 5
-vat[1]	*a suffix implying possession* X 22
-vat[2]	*a suffix for the past active participle* II 4F, III 17, 30, IV 4, VIII 5, X 13
-vat[3]	*a suffix of unknown value* VIII 8, 9
vad	*to speak* vada II 4, III 19, 20, 21, 24, 27, 28, 30, 31, 35, VIII 5, ⟨10⟩, X 1, 2, 8, ⟨11⟩, 11F, 13, (15), ⟨18, 22⟩; vadaśva (= vadasva) III 28; vadasva IV 4
vadh	*to multiply* vadha V 2; *458*
vaptṛ	*a sower* I 4
varga[1]	*the square of a number* III 12, VII 2, 6, ⟨8⟩, 9, VIII 2, 9; *61, 81–83, 90, 91, 432–434, 459*
varga[2]	*multiplication* IV ⟨4⟩, 5, 6; vargra IV 5; *53, 82, 397, 458*
vargita	*squared* VII (1), ⟨3⟩, (5), ⟨6, 8⟩; *459*
varjita	*deprived of, decreased by* (II 7), VII 1, 5, ⟨7⟩; *457*
varṇa	*color* III ⟨12⟩, 30; *382*
vartita	*reduced* (IV 3); *93, 458*
vartya	*to be reduced* ⟨II 2, III 12, 34⟩, IV 5, V 2, VII 2, 9, ⟨VIII 3, 6⟩; *53, 82, 83, 93, 458*
varṣa	*a year* (III 25), X (11), 21; va⟨rṣa⟩ IX 1, 4, X 1, 6, 8, 10, 12, ⟨16⟩, 20; *89, 109, Tables 12.1, 12.7*
valli	*a creeper* (IX 2)
vasiṣṭha	*a proper name* X 27; *85, 461*
vastra	*a garment* VIII 10, ⟨X 9⟩; *135, 140, 387*
vā	*or* ⟨I 11⟩, III 5, 26, 28, ⟨IV 11⟩
vā⟨?⟩	= va⟨?⟩ *a measure* X 7; *131*
vāṇijya	*trade* (III 26)
vāṇijyaka	*a merchant* IX 3; vāṇijjaka (III 26)
vāyu	*wind* X 12

vāsara	*a day* X 16
vāsudeva	*name of a god* IX 2; *460*
vāha	*a draught-animal* V 5, 6; *401*
vāhaka	*a bearer* ⟨II 7⟩
vāhinī	*a division of an army* ⟨X 23⟩; *428, 455*
vi-	*less* (IV 6), X 8; *458*
viṃśa	*the twentieth* VIII 10; viṃśat? (III 8)
viṃśati	*twenty* III 28, ⟨IV 9⟩, (VI 2), X 11; viṃśa III 18, V 3, (5), X 25; viṃśatika X 1; vīha VII 11; *46, 54*
viṃśatitama	*the twentieth* viṃśatima ⟨III 15⟩
vikraya	*selling* VIII (6), 7, 8, 9, 10
vikrī	*to sell* vikṛṇāti (= vikrīṇāti) VIII 6, 7; vikrīyate III 1; *50*
vikrīta	*sold* III 1, VIII 9
vicakṣaṇa	*a learned man* X 23
vicāraṇa	*investigation* III 29
vid	*to know* vecchi (= vetsi) VI (1), 2; vetsi I 4
vidita	*known* III 3
vidyādhara	*a class of semi-divine beings* X 15; *460*
vidhāna	*a rule* I 8, VIII 10, IX 3, ⟨X 24⟩
vidhi	*a rule* III 1, 30, IV ⟨4⟩, 9, VIII 3, X 5, 17, 25; *309, 318, 429, 439*
vinikṣip	*to throw, put down, add* vinikṣipya V 2, VI 4; *457*
vinirdiś	*to point out* vinirdiśet I 8, III 1, 15, 19, (36), (V 1)
vinyas	*to put down* vinyase (= vinyaset) IV 5; vinyaset ⟨IV 7⟩; vinyasye (= vinyaset) IV 4
vinyasta	*put down* piṇyasta IV 6; viṇyasta IV 5
viparīta	*inverse* III 1
vipra	*a* brāhmaṇa III 17
vibhakta	*divided* I 17, III (5), 6, 7, 8, 9, (31), (IV 7), V 1, VIII 3, 8, 9; *93, 366, 458*
vibhaktavya	*to be divided* IV 10, VIII 9; *458*
vibhaj	*to divide* vibhajet IV 5; vibhajya III 16; vibhājayet III 36; *458*
vibhava	*property* III 3
vibhājita	*divided* III 8, (17), VIII (4), ⟨5⟩; *458*
vimiśrita	*mixed up, increased by* vimiśṛta VIII 8; *457*
viyoga	*difference* II (1), 2; vriyoga II 2; *457*
vila	*a hole* X 6
viliptā[1]	*a unit of arc* X 16; *113, Tables 12.6, 12.7*
viliptā[2]	*a unit of time* vi⟨liptā⟩ III 13; *109, 112, Table 12.1*
vivarita	*expounded* VIII 3
vivardhita	*expounded* III 1; *84, 85*
viśārada	*an expert* X 22
viśāla	*large* (X 7)
viśudh	*to subtract* viśeddhya (= viśodhya) III 14; viśoddhya (= viśodhya) III 1, (4), 14; viśodhayet III (4), 36; viśodhya ⟨III 1⟩; *458*
viśeṣa	*difference* I 8, 17, III 6, 7, 8, 9, VIII 2, 3, 4, 5; *93, 458*
vistāra	*width* X 7
vihā	*to abandon, lose* vihīyamāna (X 9); *458*
vīkṣa	*a visible thing* vekṣa III 27; *52*

vṛj	*to subtract* varjayet (VII 3); *457*
vṛt	*to exist* vartate (III 15)
vṛddhi	*increase* III 26, 27; *457*
vṛnda	*a heap, quantity* II 5
vega	*speed, violence* X 12
veṇu	*a bamboo* venu IX 2
vai	*indeed* IV 6, VIII 5, IX 2, 3, X 22
vaipulya	*width* V 5
vyaya	*expense* VIII 3, IX 1, 2, 3, 4, X 24F, ⟨25⟩
vyavahārika	*practical* (I 5?)
vyākṛta	*divided, cut into pieces* vākṛta X 11
vyāpta	*reached* (III 26)
vyūha	*arrangement* X 22
vraj	*to go* vrajati III 21
vrīhika	*rice* vrīhaka I 3
śakya	*able* III ⟨5⟩, 29
śaṅku	*a peg* śaṃku X 8
śata	*a hundred* I ⟨3⟩, 3, II 9, 10, III 6, 16, 19, 20, 21, IV ⟨1, 2⟩, 4, 7, (8), V 1, 3, 5, 6, VIII 8, IX 1, 3, X 2, 7, 10, 11, 12, 15, 18, 19
śatrudamana	*a proper name* (X 23); *460*
śanais	*slow* śa⟨nais⟩ III 18
śabd	*to speak* śabdava (*error for* śabdaya) I 1
śara	*an arrow* X 14, 22; śa⟨ra⟩ X 14, ⟨22⟩
śarva	*name of a god* X 13; *460*
-śas	*a suffix implying installment or repetition* III 23, 30, 31; -ṣas II 7
śastra	*a weapon* (X 22)
śālā	*a house, compartment* II 6, III 24; śā⟨lā⟩ II 6; *40*
śāli	*rice* śā⟨li⟩ III 6
śāstra	*science, discipline* X 15, 27
śiras	*a head (of an army)* X 21; śi⟨ras⟩ X 22; śira (X 22); *53, 428, 455*
śiva	*name of a god* X 27; *143, 460*
śīghra	*quick* śī⟨ghra⟩ ⟨III 18⟩
śuddha	*subtracted* III 5, 15, 36, V 1, VI 2; *458*
śuddhi	*subtraction, difference* II 8, 9, ⟨III 12⟩, VII 3, 6, ⟨7⟩; *431, 432, 434, 458*
śudh	*to purify, subtract* śuṃdyati (= śudhyati?) X 1; śodhayet VI 1, 2
śulka	*tax* (I 8), III 24, 27, VIII 10; *140, 387*
śūdra	*a man of the fourth cast* sūḍha VII 11, 12; *53*
śūnya	*vacant, zero* IV 4, 5, 6, 8, (10); śūṇya I 7, IV (4), 5, 7, 9, (11); *91, 143*
śūlin	*name of a god* X 13; śū⟨lin⟩ IX 1; *143, 340, 460*
śṛ	*to hear* sruṇusva (= śṛṇuṣva) III 34
śeṣa	*remainder* I 5, 7, 9, 15, II 1F, ⟨2⟩, 5, 6, 7, ⟨8⟩, 9, III 2, 3, 5, 8, 9, ⟨11⟩, 13, 15, 18, 19, 20, ⟨21⟩, 22, 23, 24, 25, 26, 27, 28, 29, 30, ⟨31⟩, 35, IV 11, V 1, VI 1, (2), VII 1, 2, 3, (4), 5, 6, ⟨7⟩, 9, VIII 5, 7, 8, 9, 10, (IX 2); śe⟨ṣa⟩ I 13F, III 13, 20, ⟨21⟩, 22, 23, 24, 25, 28, 29, 30, 31, 34, IX 1, X 3, 4, 15, 20; śeṣya III 28; ṣeṣa II 1F, III 36; *93, 407, 433, 434, 458*
śodhanīya	*to be subtracted* II 8; *458*

śodhita	*subtracted* ⟨II 5, III 18⟩; *458*
śodhya	*to be subtracted* III 18; śoddhya VI 1, 2; *458*
śobhanā	*lustre* X 1; *121*
śobhā	*lustre* X 1
śaulkika	*a tax officer* III 31, (VIII 10)
śyāmalikā	*a deer* sāmalea VII 11; *55*
śrama	*exercise, hard work* III 30
śliṣṭa	*adherent* (III 12, 13), VII 6; śliṣṭha III 12, VII 1, (3), 6; *431, 433, 434*
śvetikā	*a monetary unit* śve⟨tikā⟩ X 3; *119, Tables 12.10–12.12*
ṣa⟨?⟩	I 12
ṣaṭka	*six* V 5; ṣaḍga? (VIII 5)
ṣaṭpañcāśat	*fifty-six* ṣaṭpaṃcāśa VIII 9; *47*
ṣaṭpañcāśat-tama	*the fifty-sixth* ṣaṭpaṃcāśama (VIII 9)
ṣaḍviṃśati	*twenty-six* IV 7; śaḍviṃśa VII 13; *46*
ṣaḍviṃśati-tama	*the twenty-sixth* ṣaḍviṃśatima (III 32)
ṣaṣ	*six* I 1, ⟨3⟩, 12, 15, III ⟨1, 10⟩, 18, 25, 27, ⟨34⟩, 35, V 2, VIII 6, 7, 8, 9, X 19, 24; śaṣ X 3, 24, 25
ṣaṣṭha	*the sixth* (V 3)
ṣaṣṭi	*sixty* ⟨III 2, X 9⟩; śaṣṭi VIII 8, X 18; śaṣṭhi III 2, 3; ṣaṣṭhi III 26
ṣoḍaśa	*the sixteenth* ṣoḍaśama III 8
ṣoḍaśa(n)	*sixteen* ⟨VI 2⟩; śoḍaśa (V 3), X 22; śoḍaṣa III 23; *46*
sa-[1]	*with* III 9, 14, ⟨17⟩, 18, 20, IV 7, 8, ⟨9⟩, VIII 5, 8, IX 2, 3, X 5, 7, 8, 12, ⟨15⟩, 19, 24, 26; sva *(an error?)* X 22; śa V 6; *457*
sa-[2]	*similar* III ⟨12⟩, 30, ⟨VII 9⟩
saṃyuta	*increased* II 4, 8, III 8, 9, 10, (13, 20), 32, 33, VII (5), 10; *457*
saṃyuti	*the sum* (II 8); *457*
saṃyoga	*the sum* (II 6, III 18); *457*
saṃvatsara	*a year* X (1), 16; *111, Tables 12.3, 12.4*
saṃvṛt	*to accomplish* saṃvartya (VIII 9)
saṃśaya	*doubt* III 5, 29; *135*
saṃśuddha	*subtracted* III 27; *458*
saṃśodhya	*to be subtracted* saṃśoddhya II 9; *458*
saṃśliṣṭa	*closer* VII 6; saṃśliṣṭha III 12, VII 3; *431–434*
saṃsāra	*the mundane world* X 27
saṃsthā	*to stand* saṃsthāpya V 2
sakṛt	*once* III 20
sakhi	*a friend* III 30, 35, X 11, (12), 13; *462*
saṅka	*property?* III 2; *52*
saṃkalita	*summation* III 8; *457*
saṃkhyā	*a number* I 12, III 6, ⟨13⟩, 17, 32, ⟨33, 34⟩, 36; sakhya X 27
saṃgama	*meeting* ⟨II 2⟩
saṃguṇ	*to multiply* saṃguṇya (I 2F), III 16, 27, 29, 32, 33, 34, 35, 36, VII 4, X (17), 26; *458*

saṃguṇa	*multiplied* I 10, III 1, 12, 35, VII 3, (5), 6, VIII 3, X 26; *434, 458*
saṃguṇana	*multiplication* (III 19); *458*
saṃguṇita	*multiplied* (III 9, 10); *458*
saṃgha	*a flock, assemblage* saṃha X 15; *52*
-saṃjñaka	*having ··· as its name* III 9, 10, (12)
saṃjñita	*named* (III 16)
satata	*constant* X 8
satera	*a monetary unit* X 14; sa⟨tera⟩ X 14; *118, 119, 125 (weight), Table 12.9*
sadṛśa	*similar* I 2, 3, 7, 8, 9, 11, 15, II 5, 6, III 2, VII ⟨3⟩, 7, ⟨9⟩
sapta(n)	*seven* I ⟨3⟩, 9, (13), III 7, 11, IV 7, (9), 11, V 5, VIII 2, 4, 5, (6), 7, (IX 1), X 10, 11
saptaka	*seven, the seventh* III 31, ⟨34⟩, (VII 13); *47*
saptati	*seventy* III 18, 20, VII 13, X (11), 18, 19
saptadaśa(n)	*seventeen* saptādaśa VI 2; *46*
saptadhā	*in seven ways* (X 11)
saptapañcāśaka	*fifty-seven* saptapaṃcāśaka II 7
saptama	*the seventh* (II 1F), V 3
saptaviṃśati	*twenty-seven* III 28, (X 3); saptāviṃśa III 28; *46*
sama	*same* I 1, 8, 9, 15, ⟨17⟩, II 1, III 5, 6, 7, 9, ⟨10⟩, 11, 12, ⟨13⟩, 14, 17, 32, VIII 4, 5, 6, X 1; samaka ⟨X 15⟩; samatā III 11, 14, VIII 5
samagra	*entire* II 5
samasta	*whole* samaśva X 16
śamāgama	*meeting* III 18
samādā	*to receive* samādāya I 1
samānayana	*calculation* I 8
samāpta	*completed* III 17, (IV 11), X (5), 11
samāhata	*multiplied* (X 22); *458*
samutpatti	*producing* IX 3
samudbhava	*born from* (X 16)
sampad	*to be produced* saṃpadyate X 24
sampanna	*produced* saṃpaṇṇa (X 24)
sampū	*to blow* saṃpūyamāṇa (X 15)
samprāp	*to reach* saṃprāpyate X 6
sambhakta	*divided* saṃbhakta VII (1), 5, 7; *458*
sammiśr	*to mix* sammiśrya III 34
samyak	*correctly* (III 27)
sarpa	*a snake* śarpa X 6
sarva	*all, every* I 12, II (4F), ⟨6⟩, III 28, 34, IV 7, 9, V 3, VII 9, IX 4, X 1, (3), ⟨20⟩, 27; śarva III 2; *457*
sarvatra	*everywhere* III 22, (VI 3); sarvattra I 3
savarṇita	*reduced to the same color* ⟨VII 9⟩
sasya	*grain* X 13
saha	*with* III 11, IX ⟨1⟩, 4; *457*
sahasra	*a thousand* X 8, 11
sahita	*accompanied by* II 2; *457*
sādhya	*to be obtained* sāḍha VII 11; *54*
sāmya	*equality* III 1, (2), ⟨4⟩, 8, 13, 33; sāmyatā (I 3, 17), III 7, 8, 15

sāyaka	*an arrow* X 22
sāra	*essence* IV 12
siddha	*a class of semi-divine beings* X 15; *460*
siddhārtha	*a unit of weight* X (1), 14; si⟨ddhārtha⟩ X 1, 3, 14; *116, 121, 122, 125–127, 130, Table 12.14*
sītā	*a proper name* X 9; *135, 136, 460*
su-	*good* X 8, 10?, 15
sukha	*easy* X 7
sundarī	*a beautiful woman* X 13; *462*
sumeru	*name of a mountain* (= meru) X 8; *461*
sura	*a god* X 8, 15; *460*
suvarṇa[1]	*gold* III (21), 32, 33, 34, 35, 36; *142* (suvarṇagaṇita)
suvarṇa[2]	*a unit of weight* X 5, 13, (21); su⟨varṇa⟩ X 5; *122, 126–130, 382, Tables 12.15, 12.16, Figure 12.1*
sūkṣma	*minute* I 8
sūtra	*a versified rule* I 8, 10F, 12, II 1F, III 1, 6, 7, 8, 9, 12, (13, 15), ⟨16, 17⟩, (19), 29, 32, ⟨35⟩, 36, IV 4, 5, ⟨V 5⟩, VI ⟨1⟩, 4, VII 7, VIII 2, 3, 4, 6, 7, 8, 9, 10, X 22, (25, 26); sūṃtra III 6; *10–11, 84–87, 142, 356*
sṛṣṭi	*the creation of the world* śṛṣṭhi X 27
senāmukha	*a division of an army* ⟨X 22, 23⟩; *134, 428, 455*
sevaka	*a servant* I 2
sevya	*to be taken care of* VIII 5
skandha	*a division, section* X 3; skhandhaka (= skandhaka) X 25; khandhaka (= skandhaka) X 25; *51, 53*
-stha	*standing at* VII 2
sthā	*to stand* tiṣṭati (= tiṣṭhati) X 27; sthāpyate III 22, 33
sthāna	*place* IV (8), 9, 11, (V 5)
sthāpana	*setting out, statement* I 3, (9), 15, ⟨18⟩, III 3, 8, (17), 19, 34, ⟨IV 7⟩, V 5, (VI 3), VII ⟨4⟩, (10), 12, IX 1, X (8), 10, 17; sṭāpana III 32; *84, 87, 142*
sthāpitavya	*to be placed* III 8
sthāpya	*to be placed* VII 1, ⟨5⟩, 7; *407*
sthita	*placed* III 4, 6, 28, IX 3
spṛś	*to touch* ṣpṛśaṃnti (= spṛśanti) X 14
smṛta	*remembered* VI 1, 2, (X 23)
sraj?	*a garland* X 10
sva[1]	*one's own* II 3, 9, III 5, 26, X 9, 18F, 24, 24F, 25; śva X 9
sva[2]	*property* III 2; *457*
svagacchite?	X 10
svīya	*one's own, the third term of a* trairāśika śveya X 25; *52, 358, 439*
hata[1]	*destroyed* X 22
hata[2]	*multiplied* III 5, 10; haṃta? III 6; *458*
haya	*a horse* III 5, 16, X 23; ha⟨ya⟩ III 5, 16; *134*
hara[1]	*a saw* X 11
hara[2]	*a divisor* I 9, III 33, VII 4, VIII 4; hrara VII 4; *458*
hartya	*to be divided* V 6; *50, 458*
hasika	*a proper name* X 27; *85, 461*

hasta[1]	*a hand* I 7, III 1
hasta[2]	*a unit of length* X 6, 7; ha⟨sta⟩ X 6; *114, Table 12.8*
hā	*to abandon, decrease* hitva (= hitvā) III 35; hitvā II 1, (1F), 5, ⟨7⟩, (8), (III 35); hīyate X 10; *458*
hāra	*a divisor* I 11, 15 (bhāgahāra); *90*
hi	*indeed* III 32, ⟨VIII 4⟩, X 10
hita	*benefit* IX 2, ⟨X 13⟩
hīna	*decreased* III 1, ⟨2⟩, (3), 35, IV 9, ⟨11⟩, VI 4, VIII 2, 6, ⟨7⟩, (X 27); hīṇa III (7), 8; hīnatā III 34; hrīṇa VIII 2; *458*
huṇḍikā	*a bill of exchange* I 8; *140, 391*
hṛ	*to divide* hṛtvā III 16, 31; *458*
hṛta	*divided* I 10, III 13, 23, 29, 31, VII ⟨6⟩, 8, ⟨9, 10⟩, VIII 10, ⟨X 25⟩; *458*
hṛti	*division* III 12, VII 3, 6, (7); *431–434, 458*
heman	*gold* ⟨III 35⟩
haihaya	*a proper name* hehaya X 22; *135, 460*

Abbreviations

AB	*Āryabhaṭīya* of Āryabhaṭa I
AD	*Aṇuogaddārāiṃ*
AKB	Vasubandhu's auto-comm. (*bhāṣya*) on the *Abhidharmakośa*
BAB	Bhāskara I's comm. (*bhāṣya*) on the AB
BG	*Bījagaṇita* of Bhāskara II
BHSD	*Buddhist Hybrid Sanskrit Grammar and Dictionary* by F. Edgerton Vol.2: Dictionary
BHSG	*Buddhist Hybrid Sanskrit Grammar and Dictionary* by F. Edgerton Vol.1: Grammar
BM	*Bakhshālī Manuscript*
B-R	*Sanskrit Wörterbuch* by O. Böhtlingk and R. Roth
BSS	*Brāhmasphuṭasiddhānta* of Brahmagupta
deś	deśavastrayantra
GK	*Gaṇitakaumudī* of Nārāyaṇa
GS	*Gaṇitasāra* of Ṭhakkura Pherū
GSS	*Gaṇitasārasaṃgraha* of Mahāvīra
GT	*Gaṇitatilaka* of Śrīpati
HGA	*Historical Grammar of Apabhraṃśa* by G.V. Tagare
JUB	*Jaiminīya Upaniṣad Brāhmaṇa*
kal	kalāsavarṇa
KS	*Kāṭhaka Saṃhitā*
kṣe	kṣetra
L	*Līlāvatī* of Bhāskara II
LM	*The Language of the Mahānayaprakāśa* by G.A. Grierson
LP	Later *Pauliśasiddhānta*
LV	*Lalitavistara*
MaitS	*Maitrāyaṇī Saṃhitā*
miś	miśraka
MMW	*A Sanskrit-English Dictionary* by M. Monier-Williams
MS	*Mahāsiddhānta* of Āryabhaṭa II
par	parikarman
PB	*Pañcaviṃśa Brāhmaṇa*
PG	*Pāṭīgaṇita* of Śrīdhara
PGT	*Pāṭīgaṇitaṭīkā* (anonym. comm. on the PG)

PM	*Patan Manuscript*
pra	prakīrṇaka
PS	*Pañcasiddhāntikā* of Varāhamihira
SS	*Siddhāntaśekhara* of Śrīpati
SSS	*Śāṅkhāyana Śrauta Sūtra*
Tr	*Triśatikā* of Śrīdhara
TS	*Taittirīya Saṃhitā*
VP	*Vāyupurāṇa*
VS	*Vājasaneyī Saṃhitā*

APPENDIX K

Photographs of the Bakhshālī Manuscript

No leaf of the *Bakhshālī Manuscript* can be restored completely, since a number of fragments are lost for ever. The restorations of the following leaves have been made only to some extent based on the facsimiles published by G. R. Kaye. Out of these, some have already been restored by Kaye himself (see the photograph opposite to p. 4 of Kaye 1927/33, which shows 29^r, $35\#^r$, and $38\#3^r$).

2^r (III 3)	2^v (III 4)	4^r (III 7)	4^v (III 8)	11^v (III 22)
23^r (IV 5)	23^v (IV 6)	25^r (IV 10)	25^v (IV 9)	26^r (IV 11)
26^v (IV 12)	$27\#^r$ (VI 4)	$27\#^v$ (VI 3)	29^r (VI 1)	29^v (VI 2)
31^r (I 9)	31^v (I 10)	$35\#^r$ (II 5)	$35\#^v$ (II 6)	$38\#1^r$ (V 5)
$38\#1^v$ (V 6)	$38\#2^r$ (V 3)	$38\#2^v$ (V 4)	$38\#3^r$ (V 2)	$38\#3^v$ (V 1)
41^r (X 18)	41^v (X 17)	42^r (X 24)	42^v (X 25)	44^r (IX 2)
44^v (IX 1)	48^r (X 20)	48^v (X 21)	51^r (II 7)	51^v (II 8)
52^r (II 9)	52^v (II 10)	55^r (X 3)	55^v (X 4)	61^r (VIII 5)
61^v (VIII 6)	69^r (I 3)	69^v (I 4)		

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I 1 70R





I 2 70V

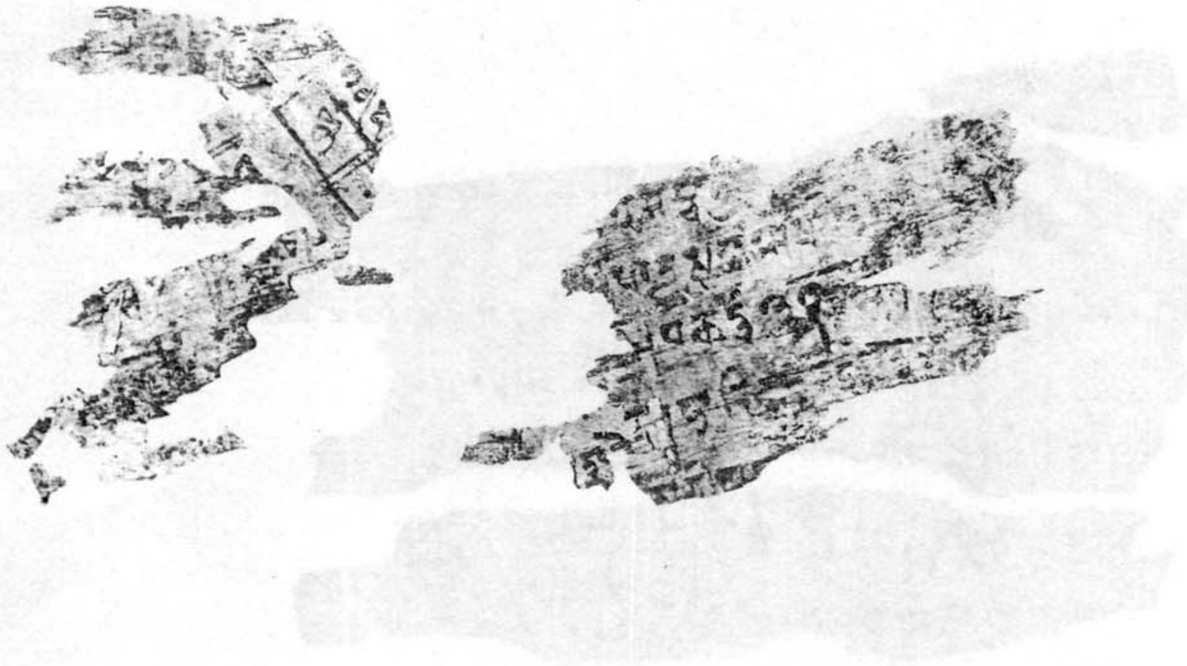
I 3 69R





I 4 69V

I 5 68R





I 6 68V

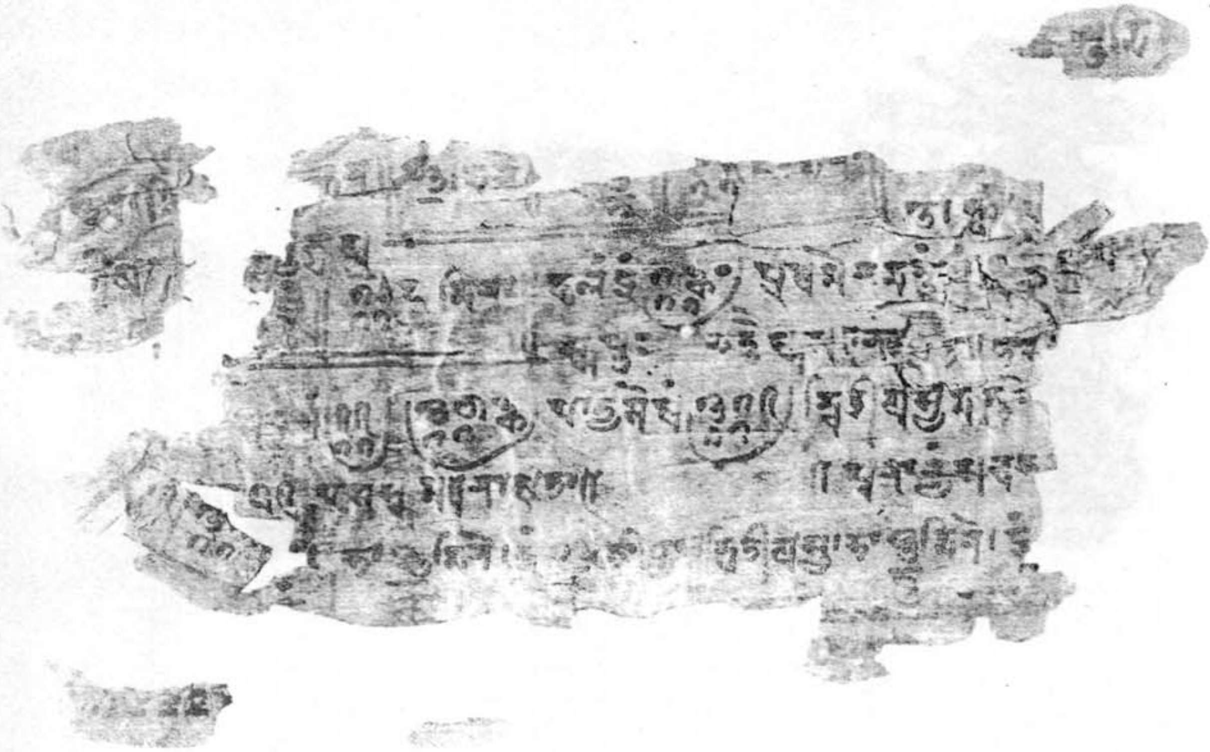
I 7 67V





I 8 67R

I 9 31R





I 10 31V

I 11 30V

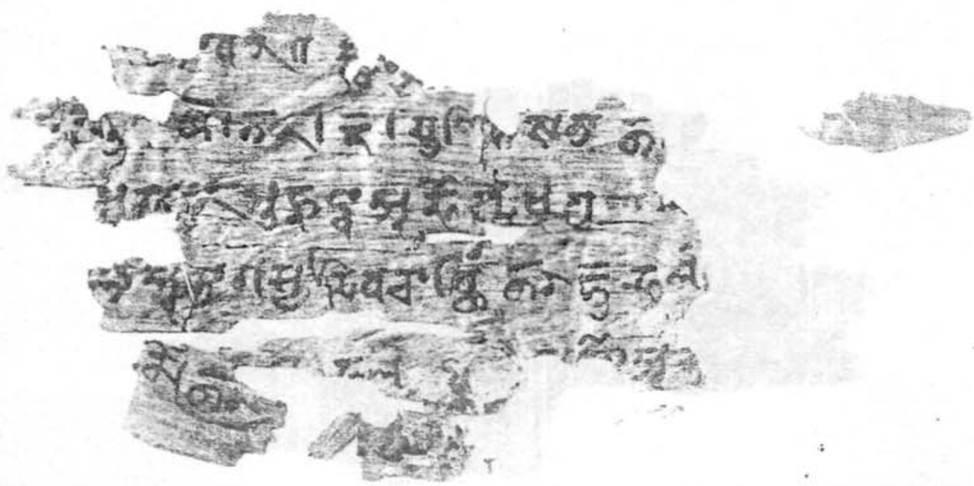




I 12 30R

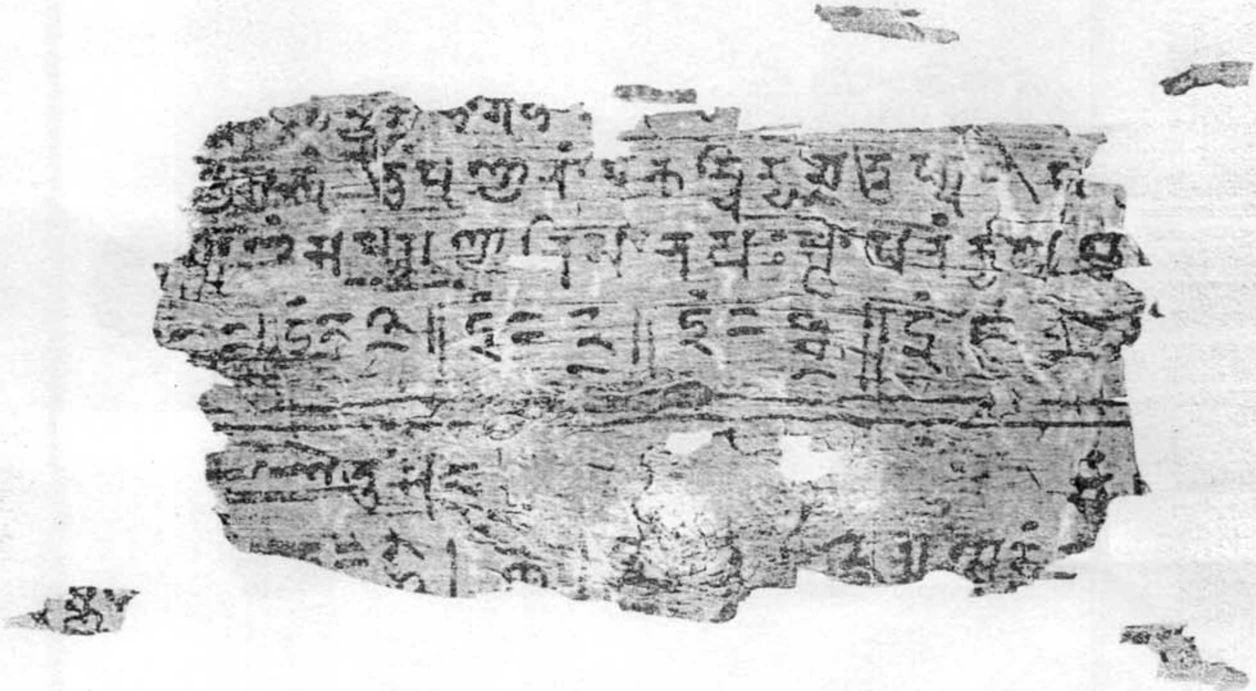
I 13 28R

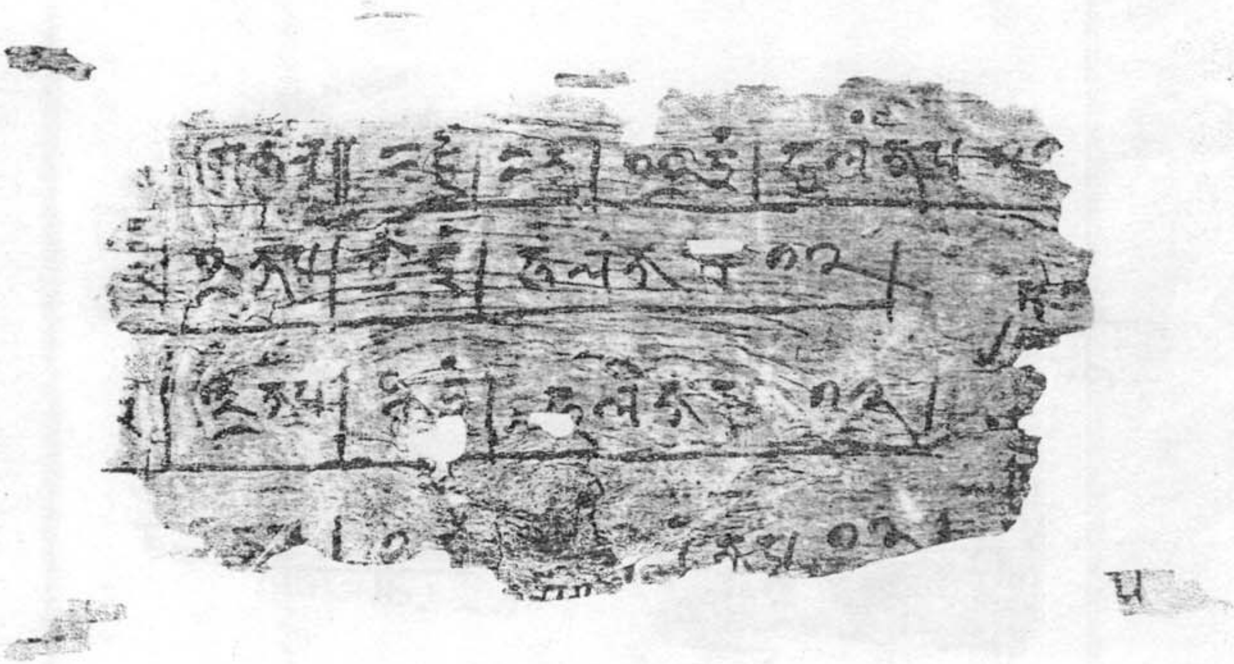




I 14 28V

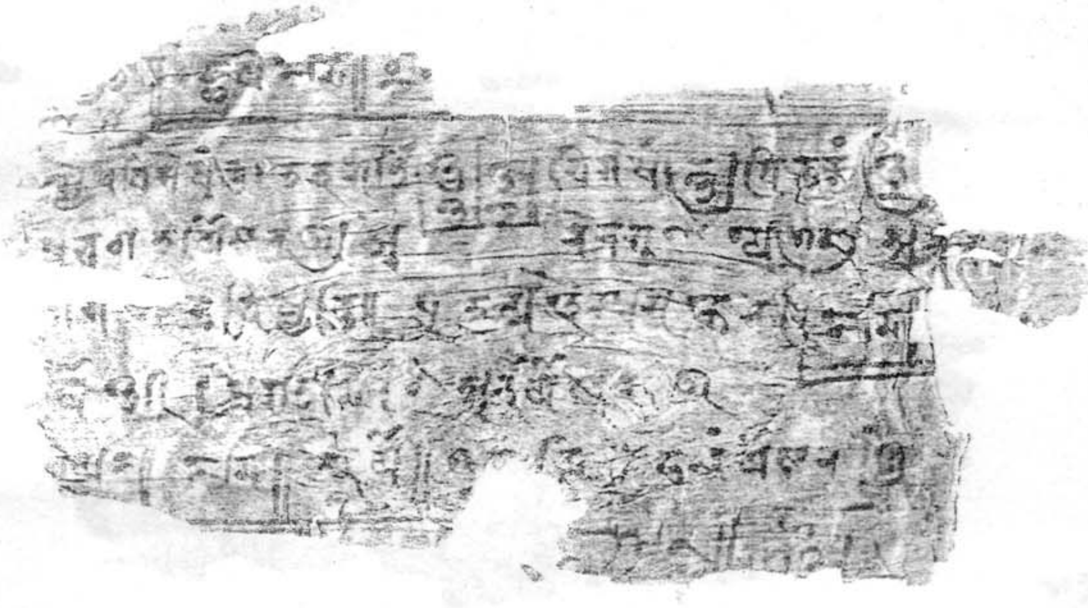
I 15 66R

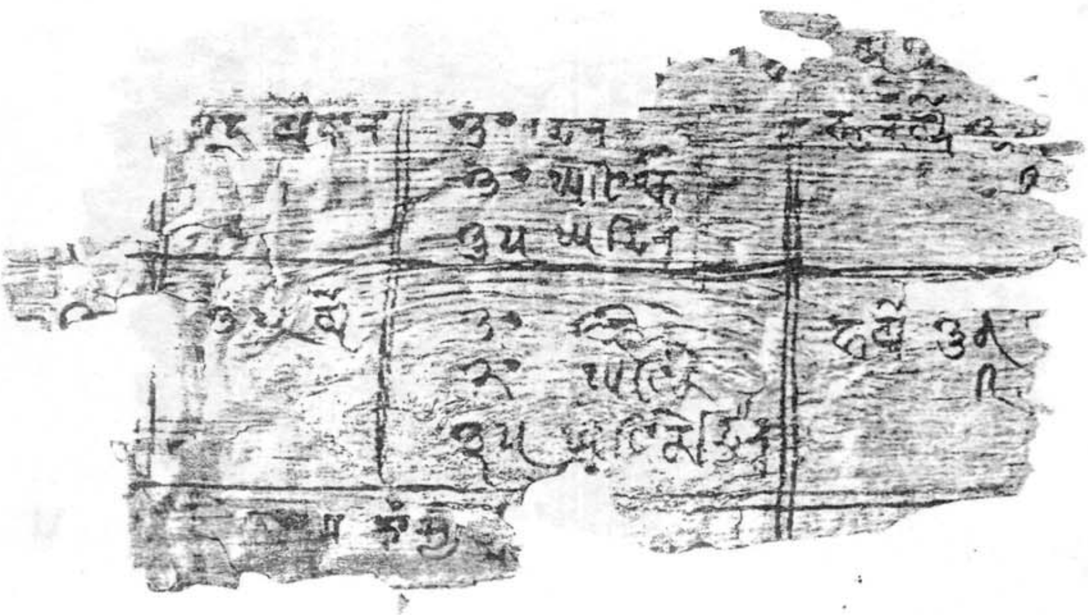




I 16 66V

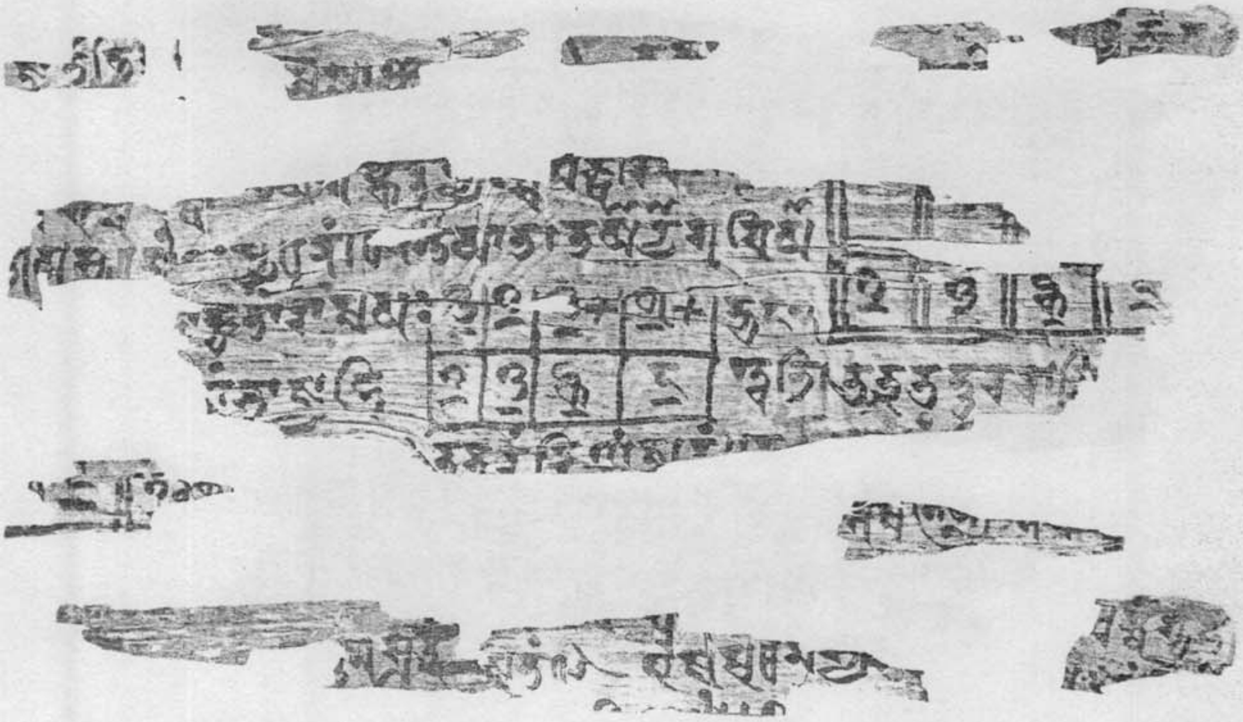
I 17 53R





I 18 53V

II 1 54R





II 2,5 35R

II 3,6 35^V





II 4 54^V

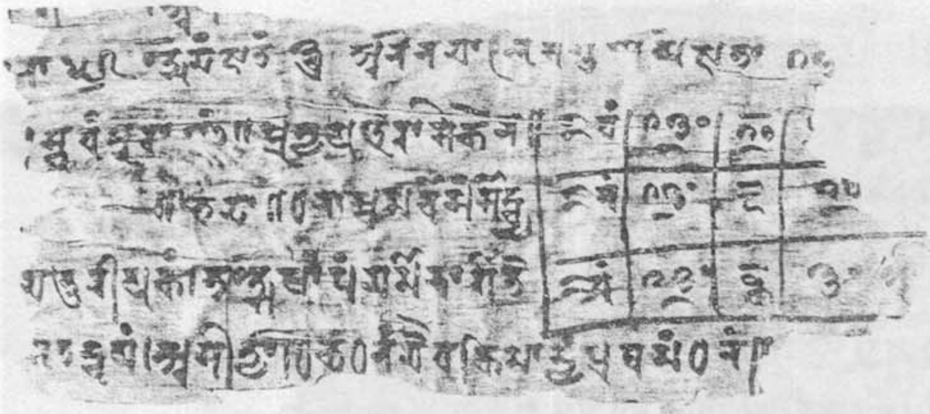
II 5,7 51R

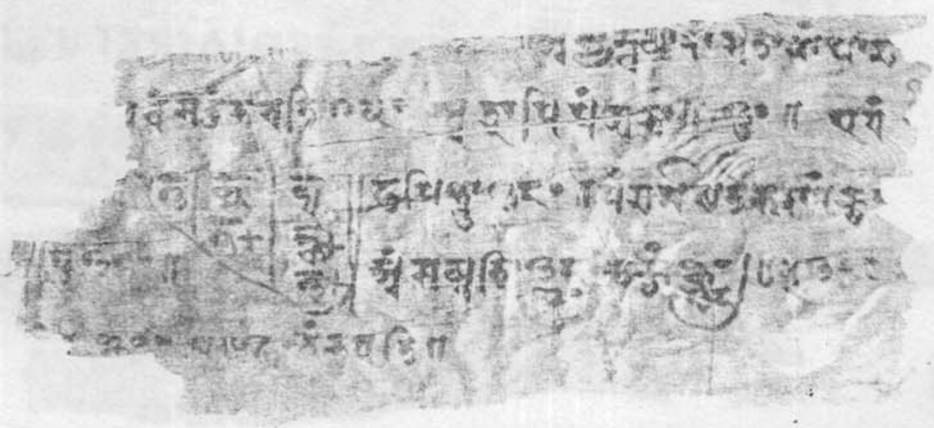




II 6,8 51V

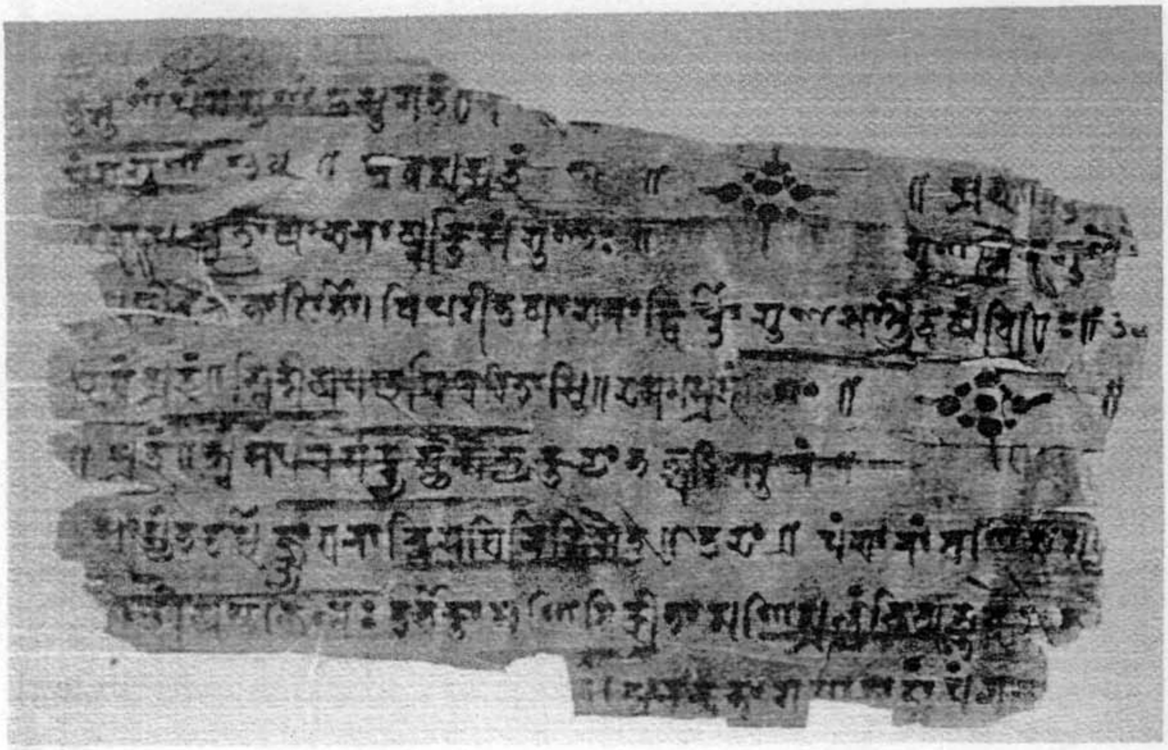
II 9 52R

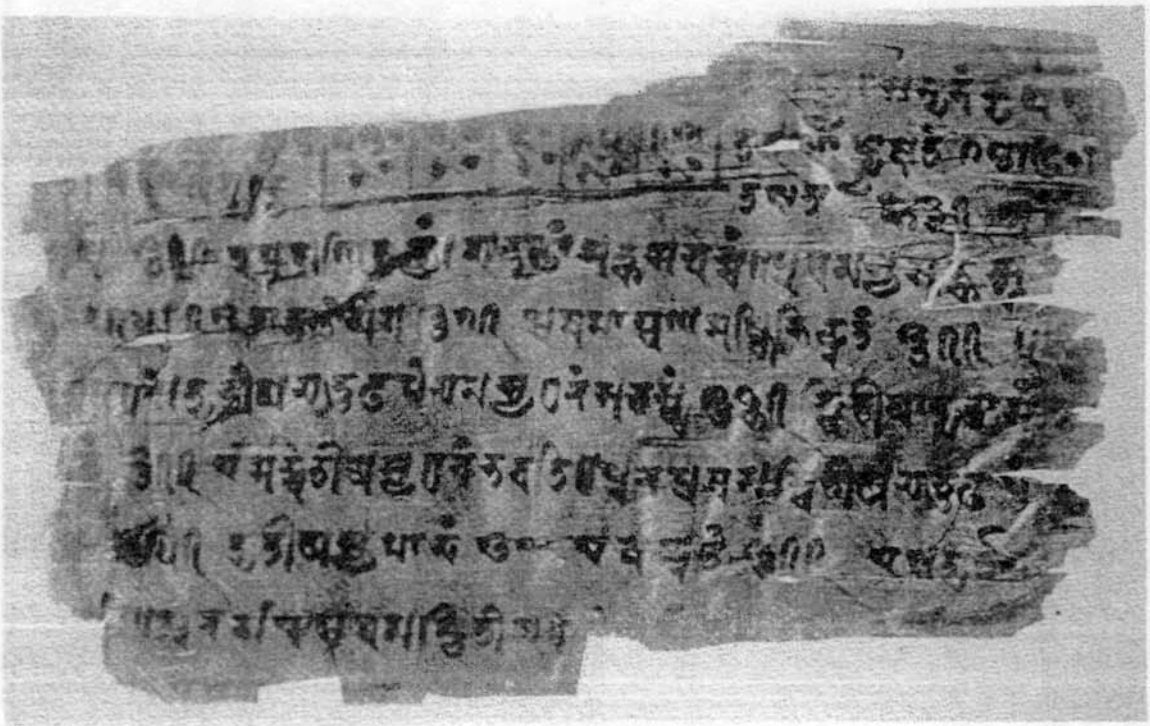




II 10 52V

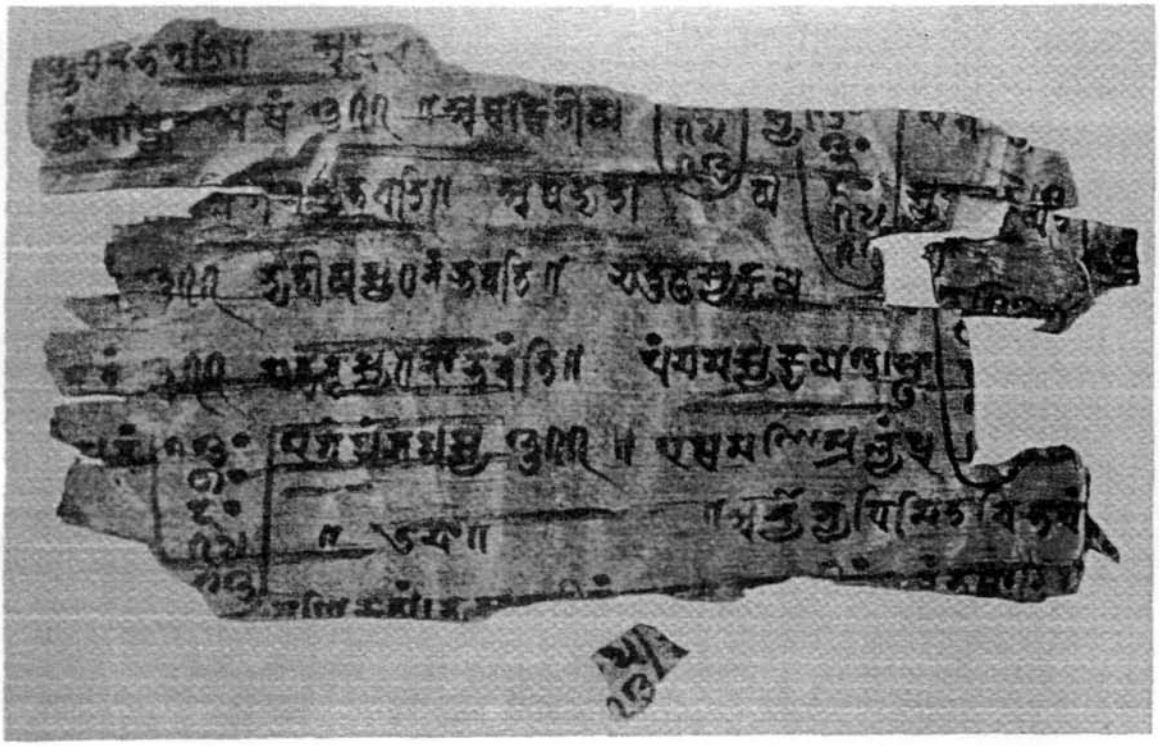
III 1 1R

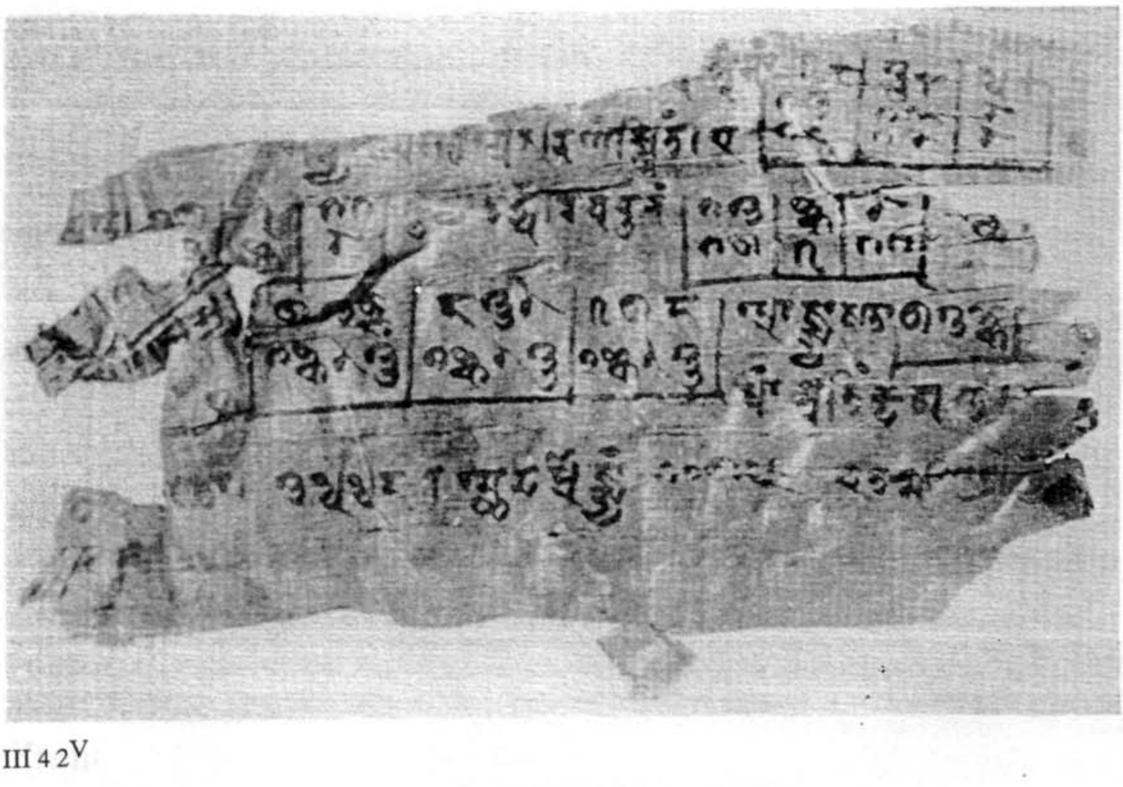




III 2 1V

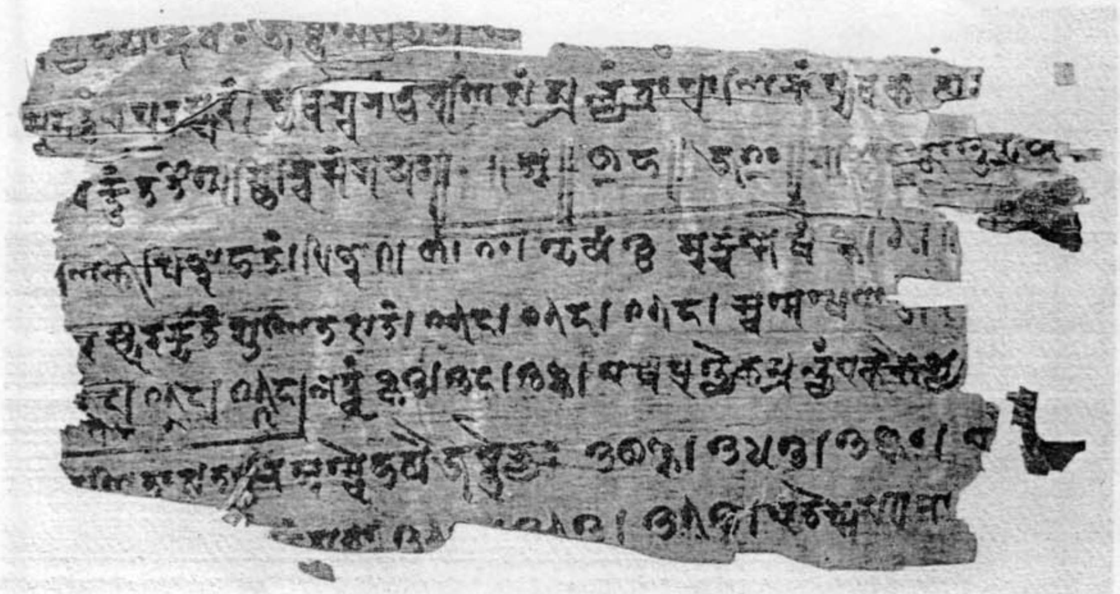
III 3 2R

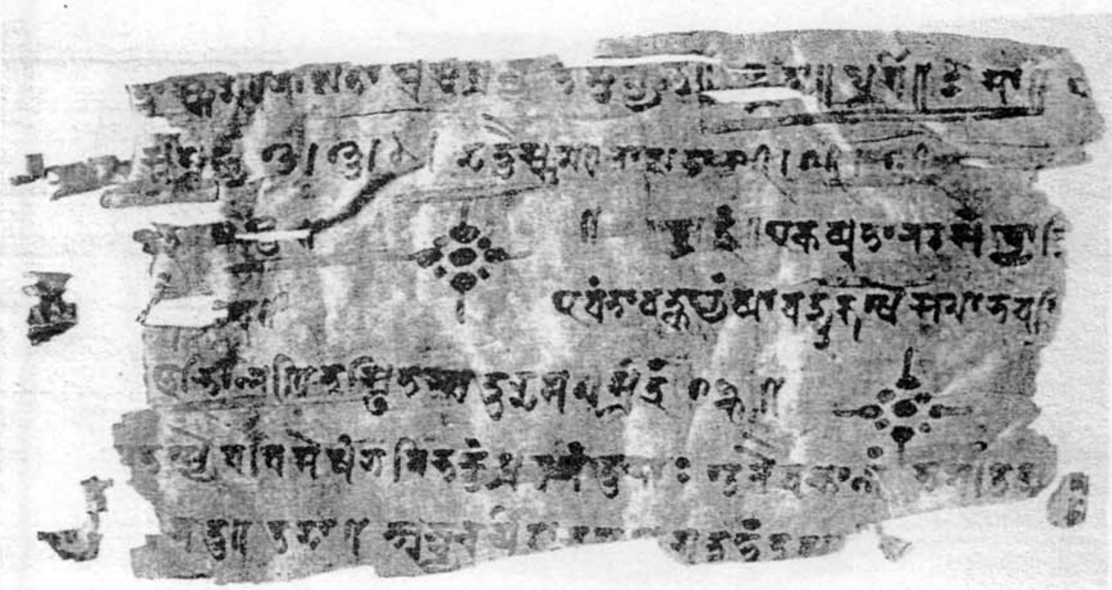




III 4 2V

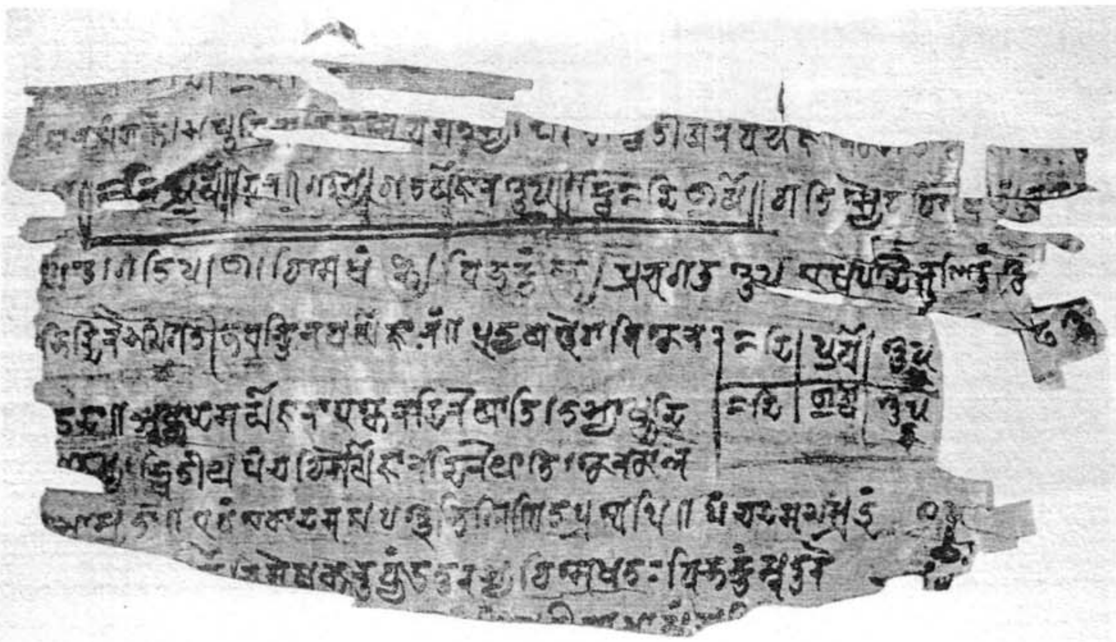
III 5 3[V]

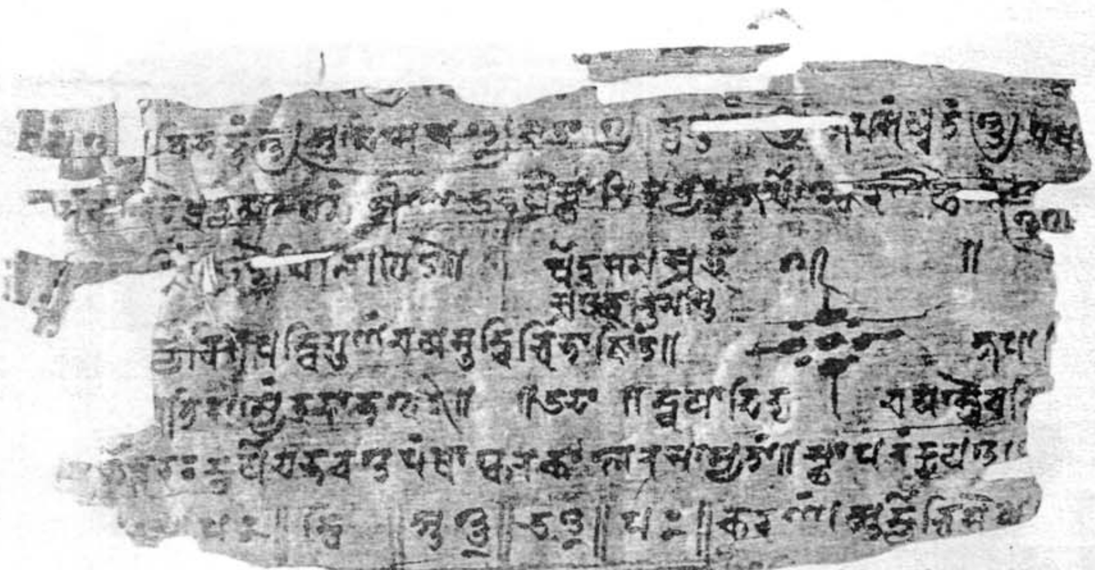




III 6 3[R]

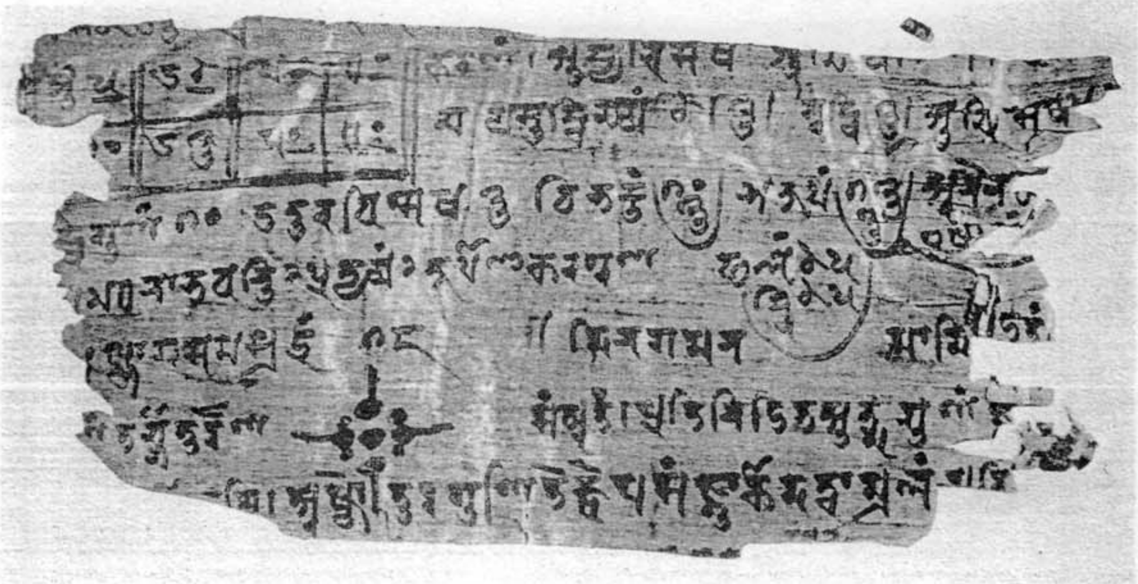
III 7 4R





III 8 4V

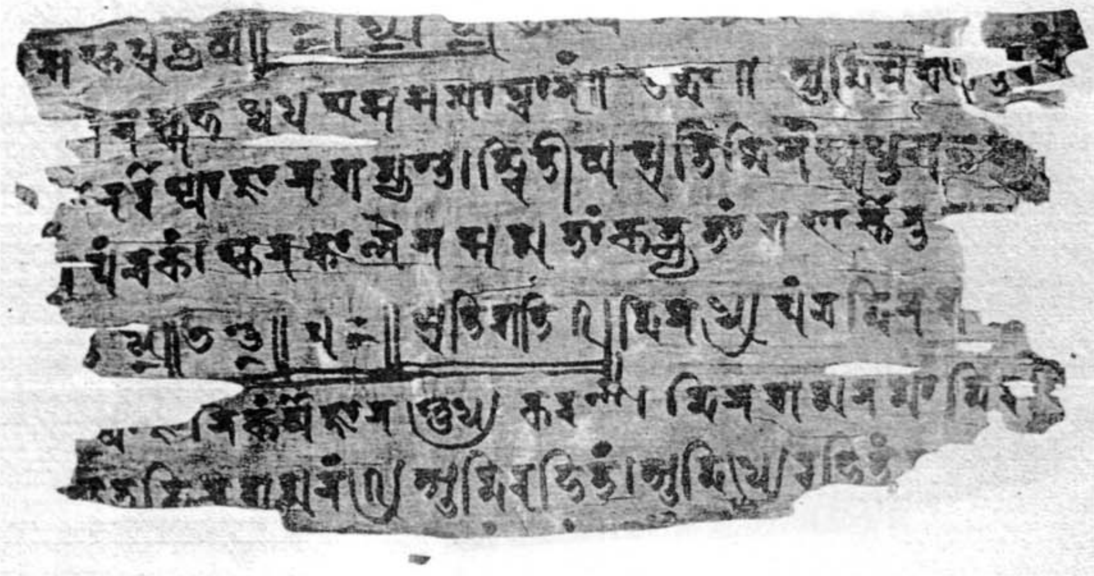
III 9 5R

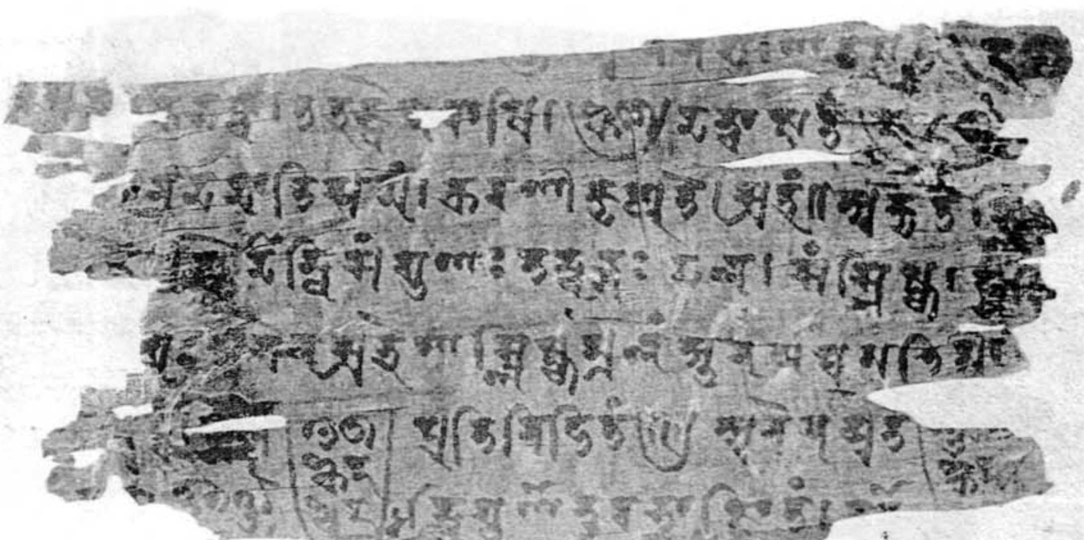




III 10 5V

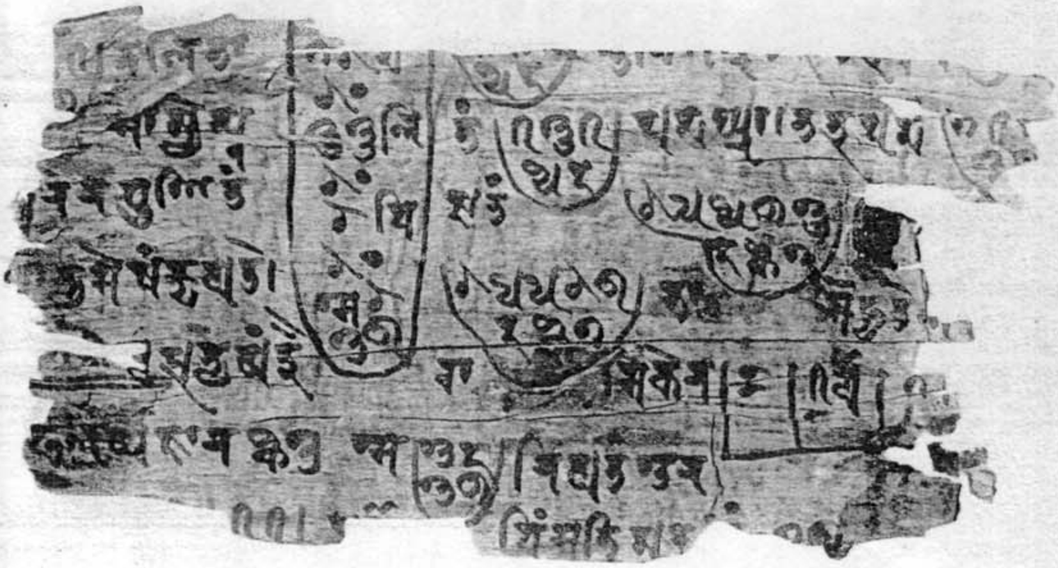
III 11 6R

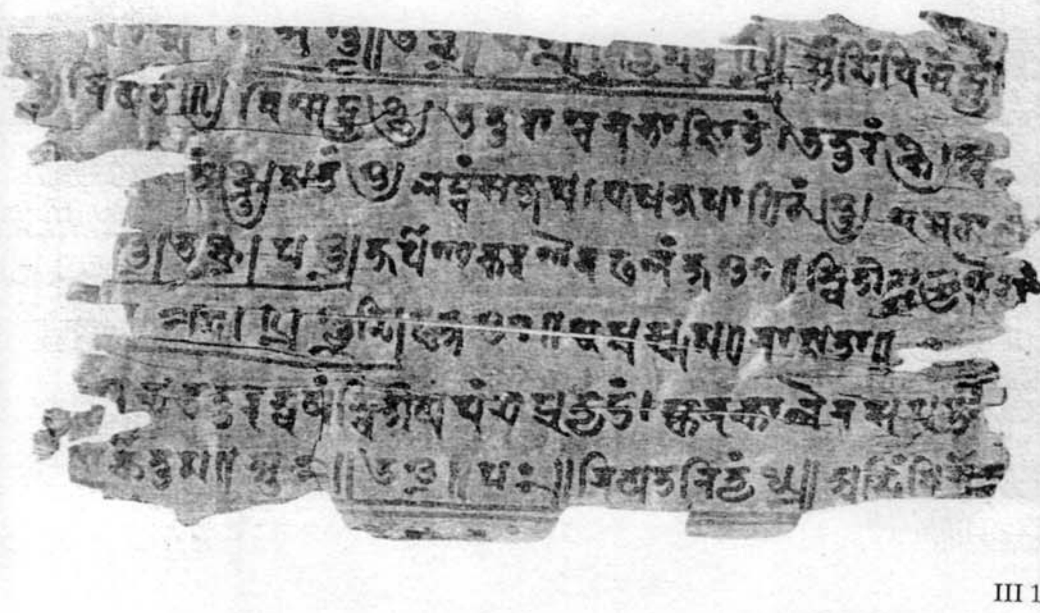




III 12 6V

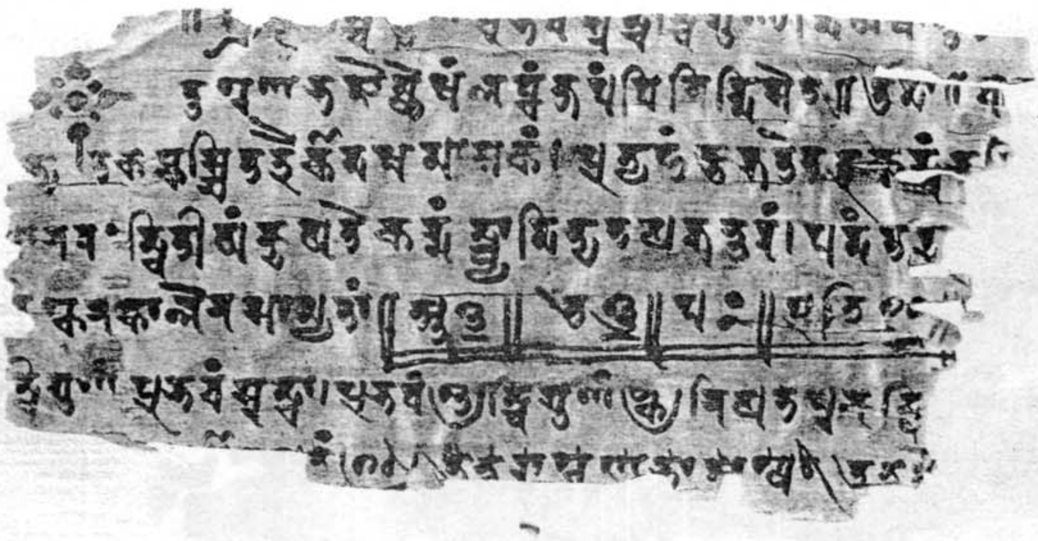
III 13 7R

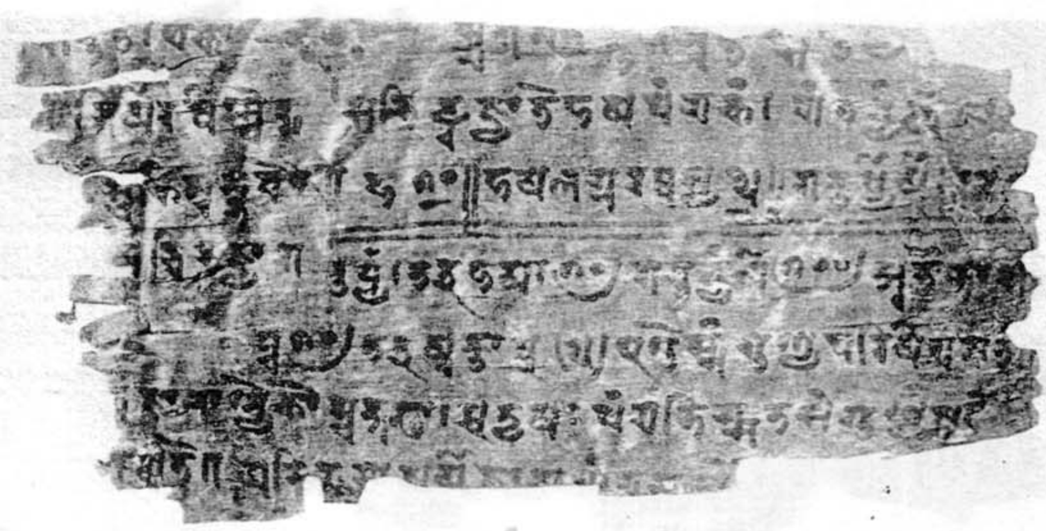




III 14 7V

III 15 8R





III 16 8V

III 17 9R

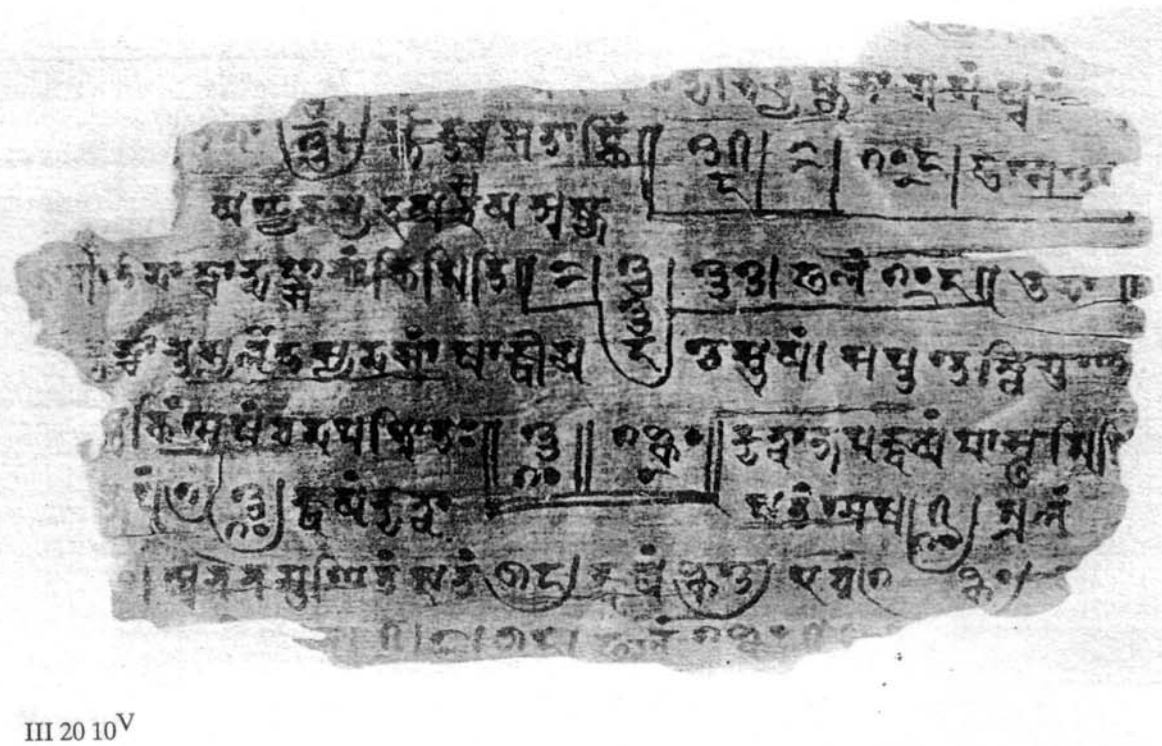




III 18 9V

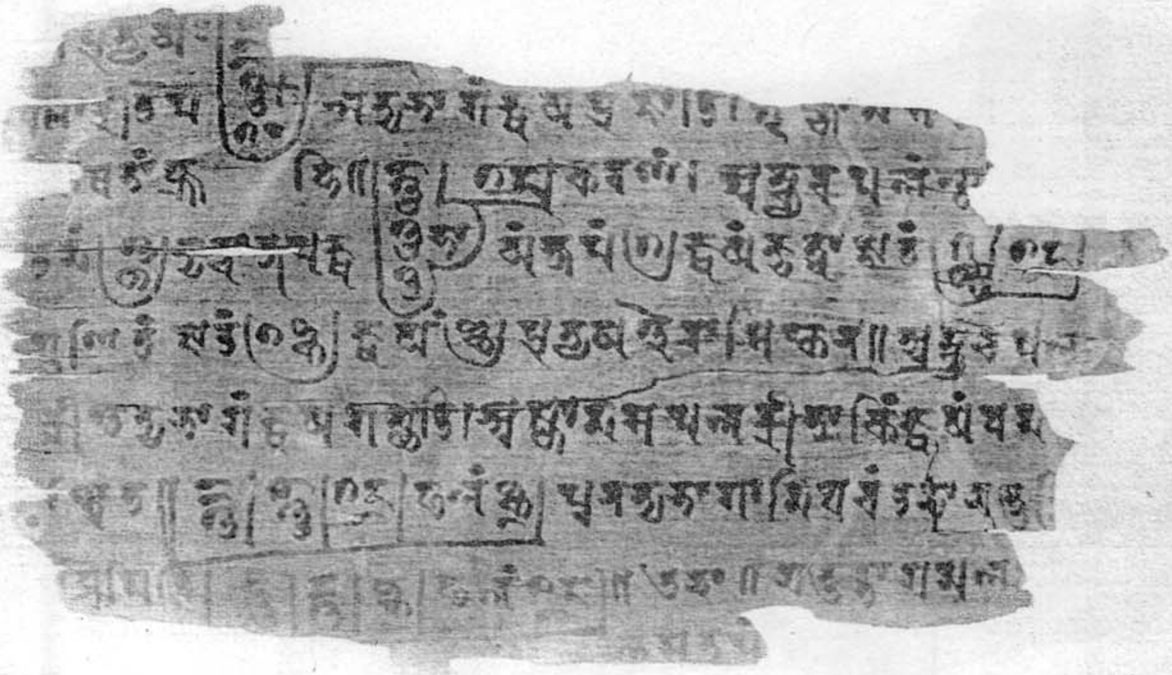
III 19 10R





III 20 10V

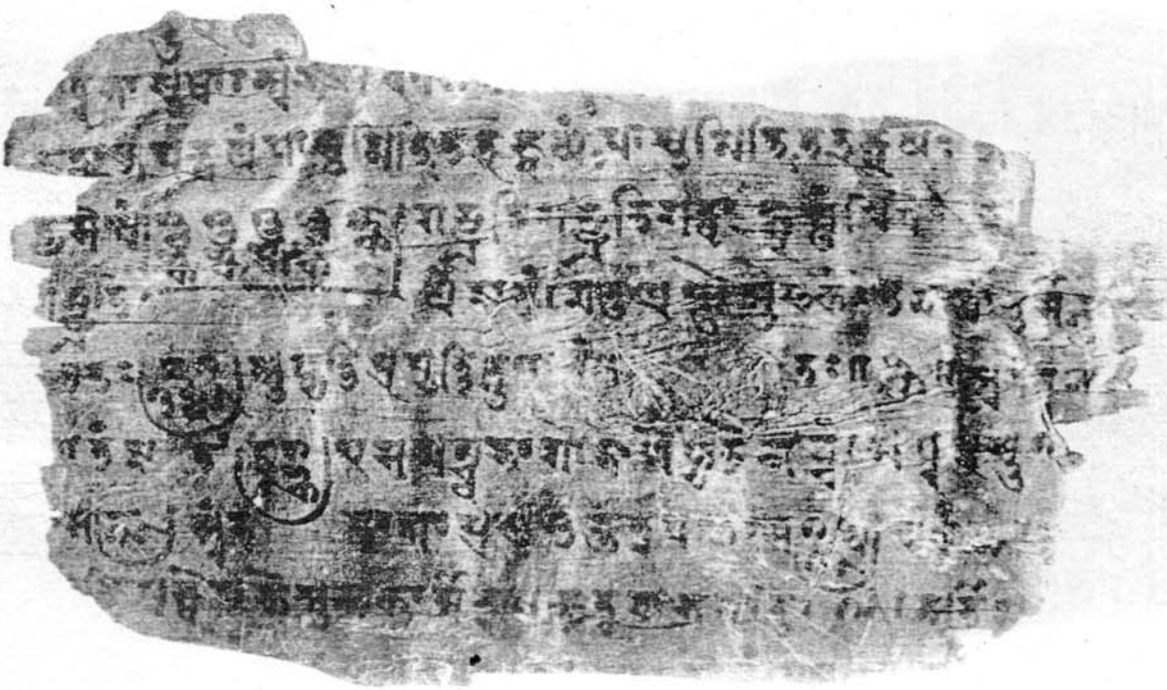
III 21 11R

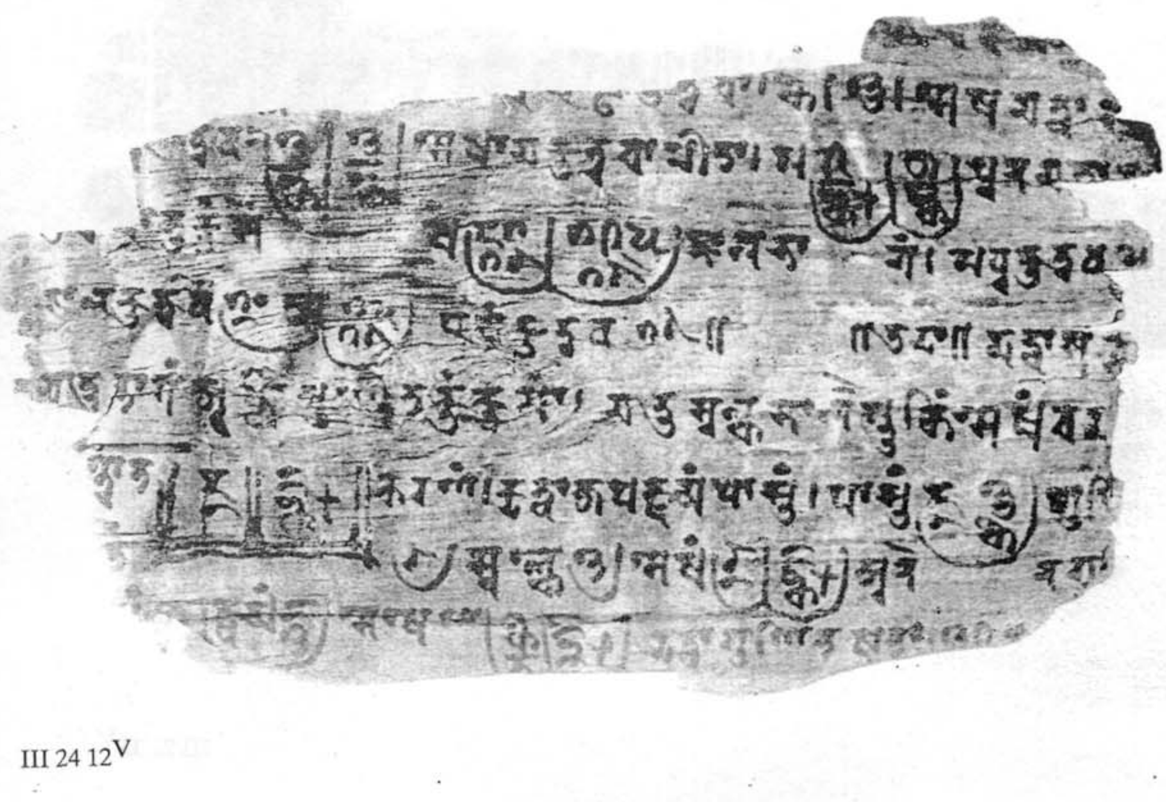




III 22 11V

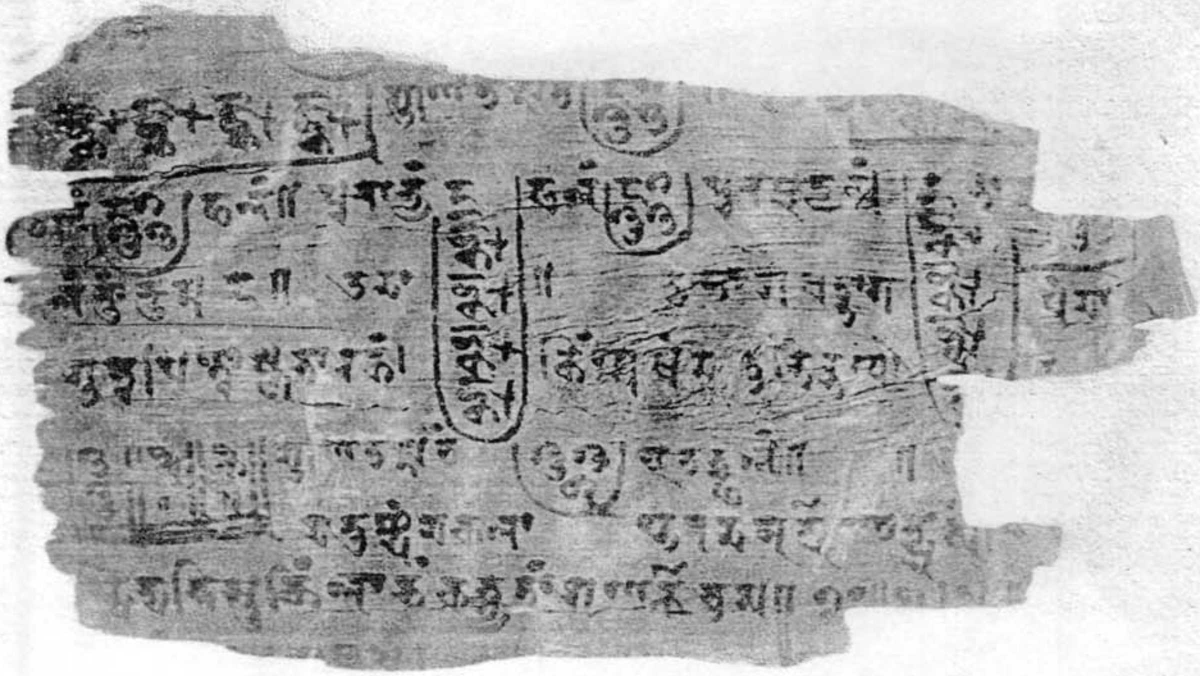
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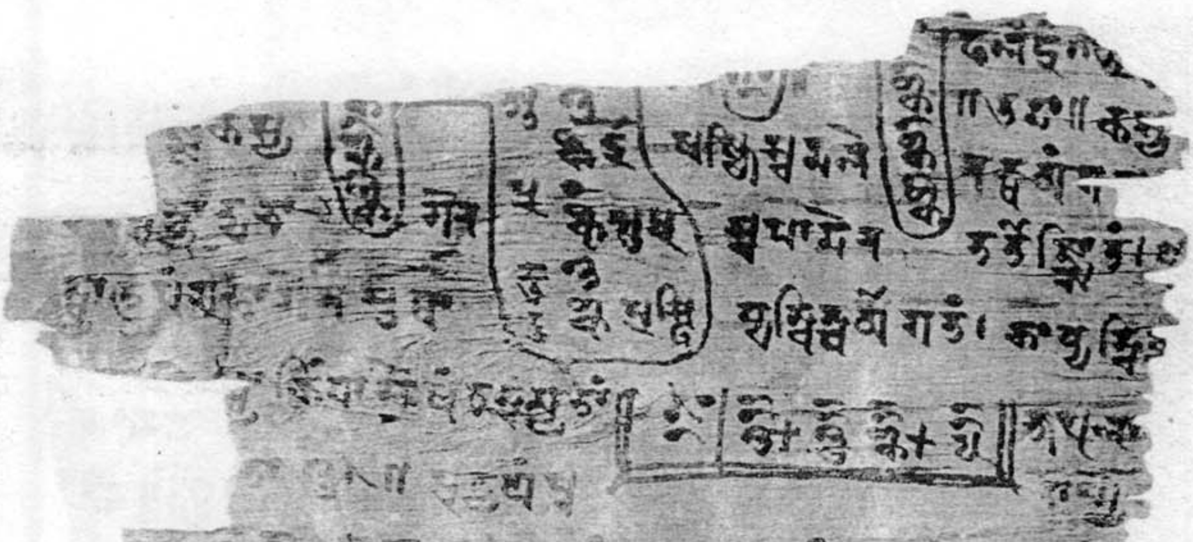




III 24 12V

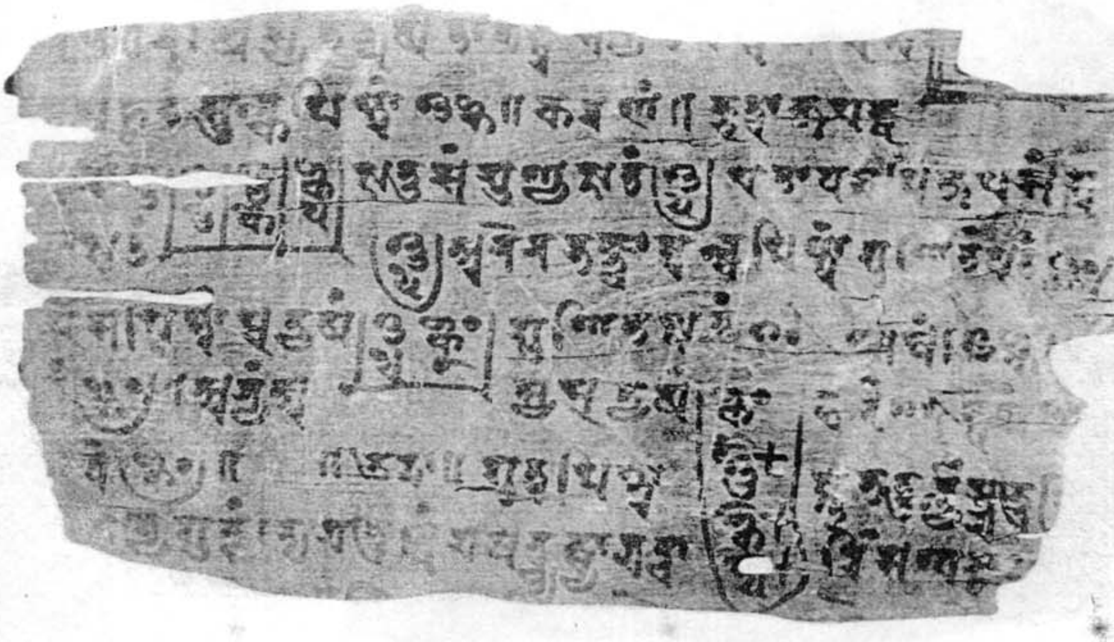
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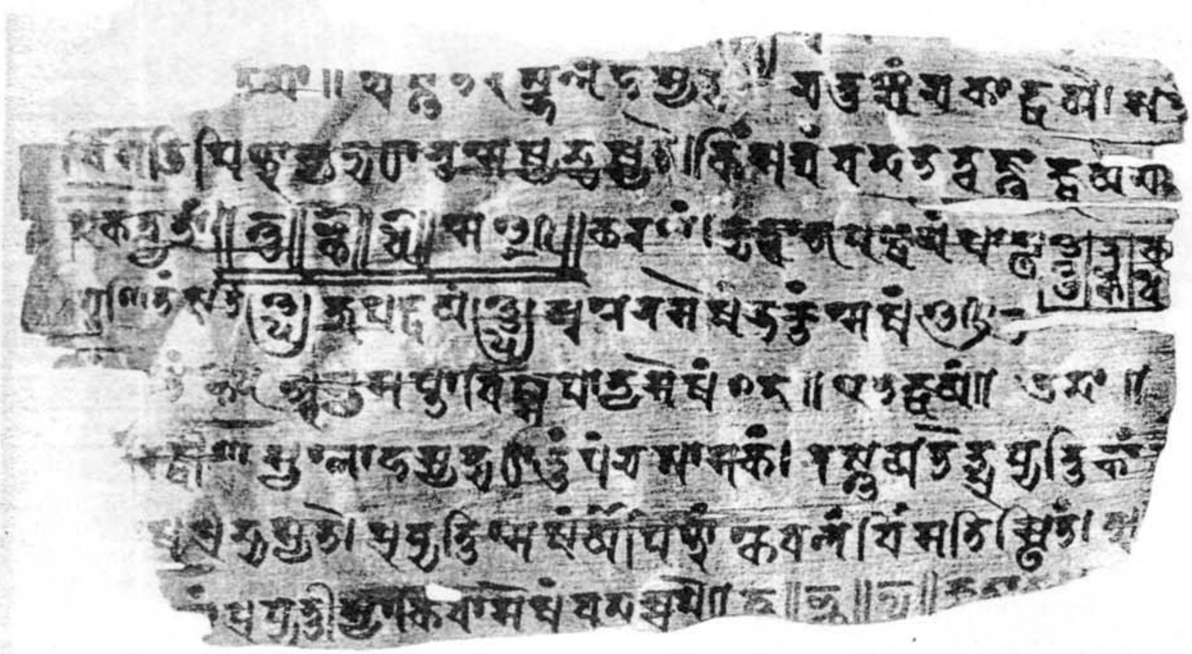




III 26 13V

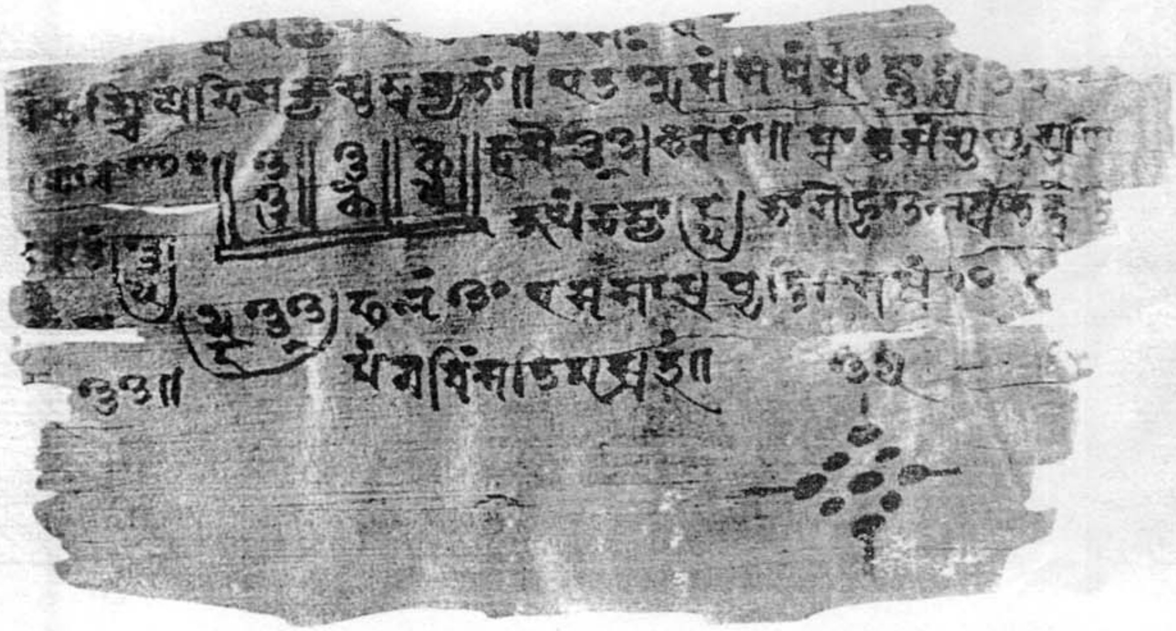
III 27 14R

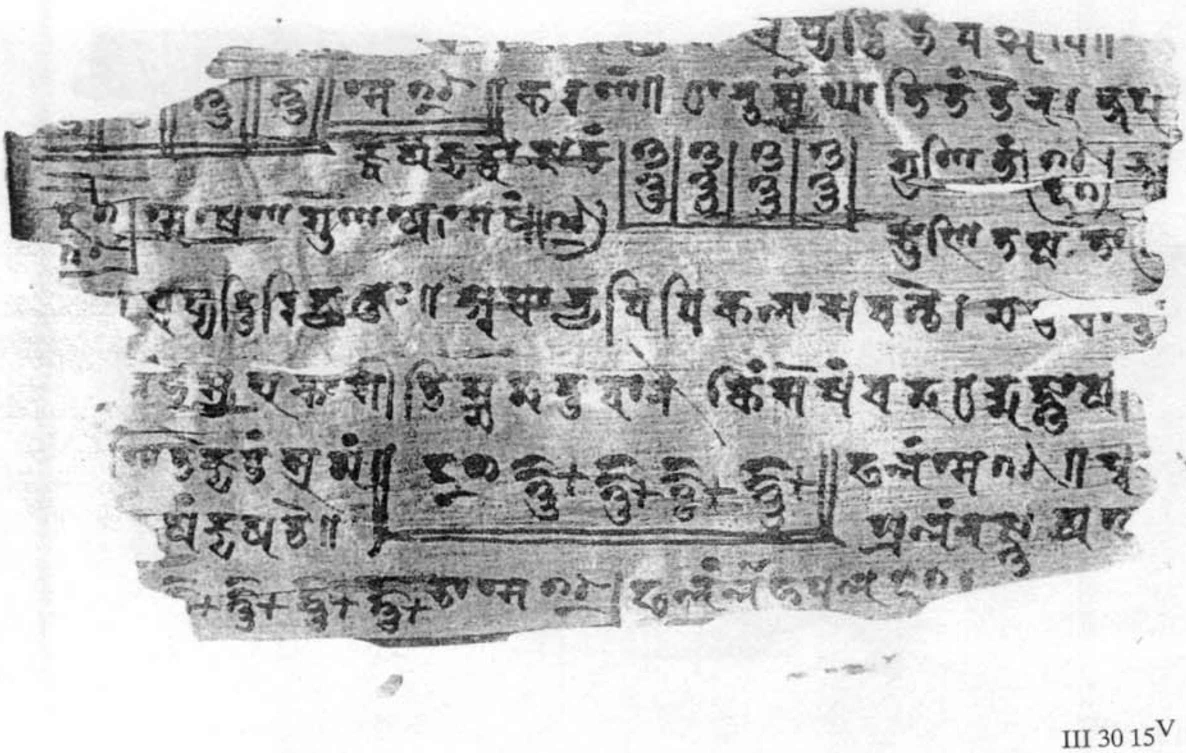




III 28 14V

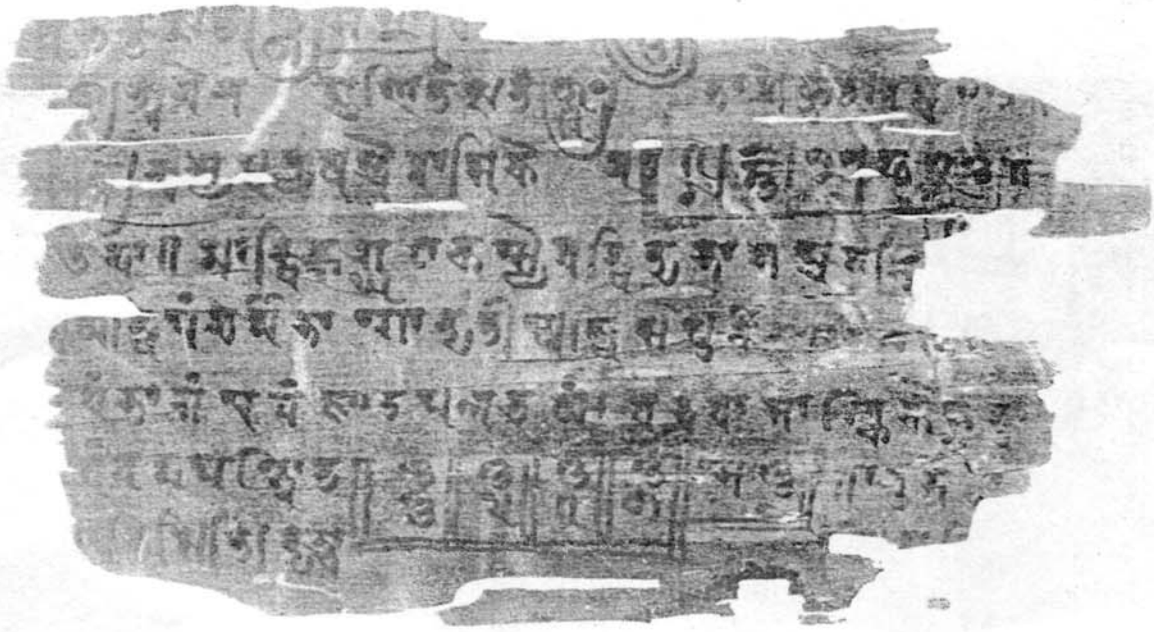
III 29 15R





III 30 15V

III 31 16R

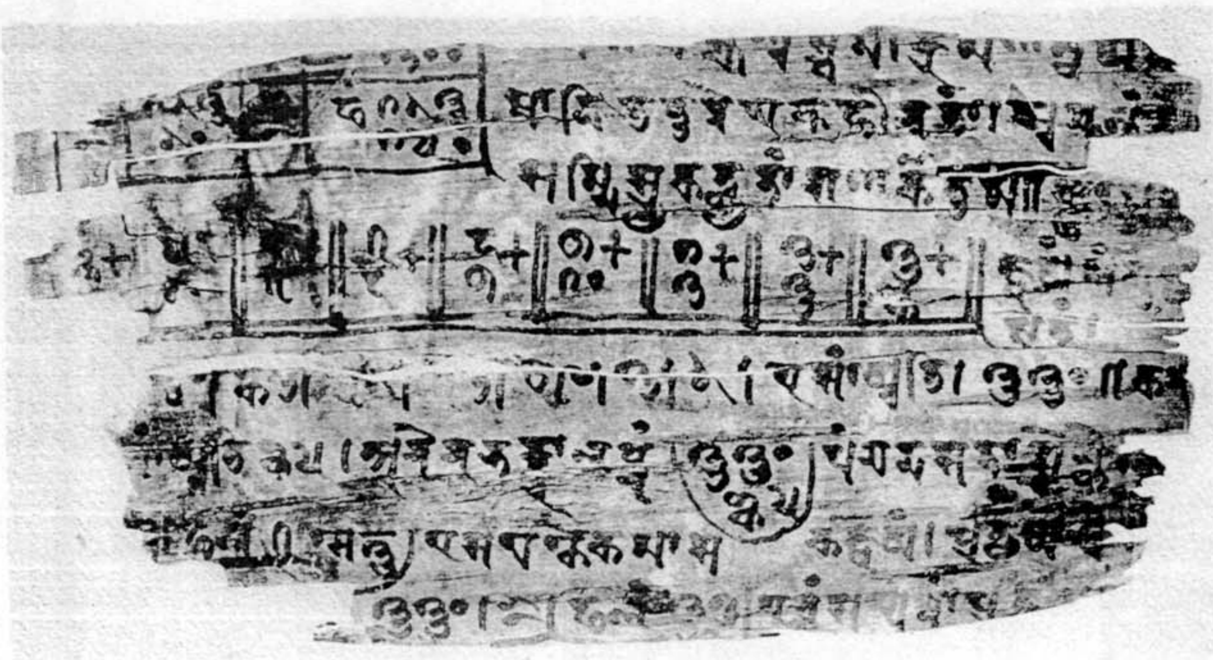




III 32 16V

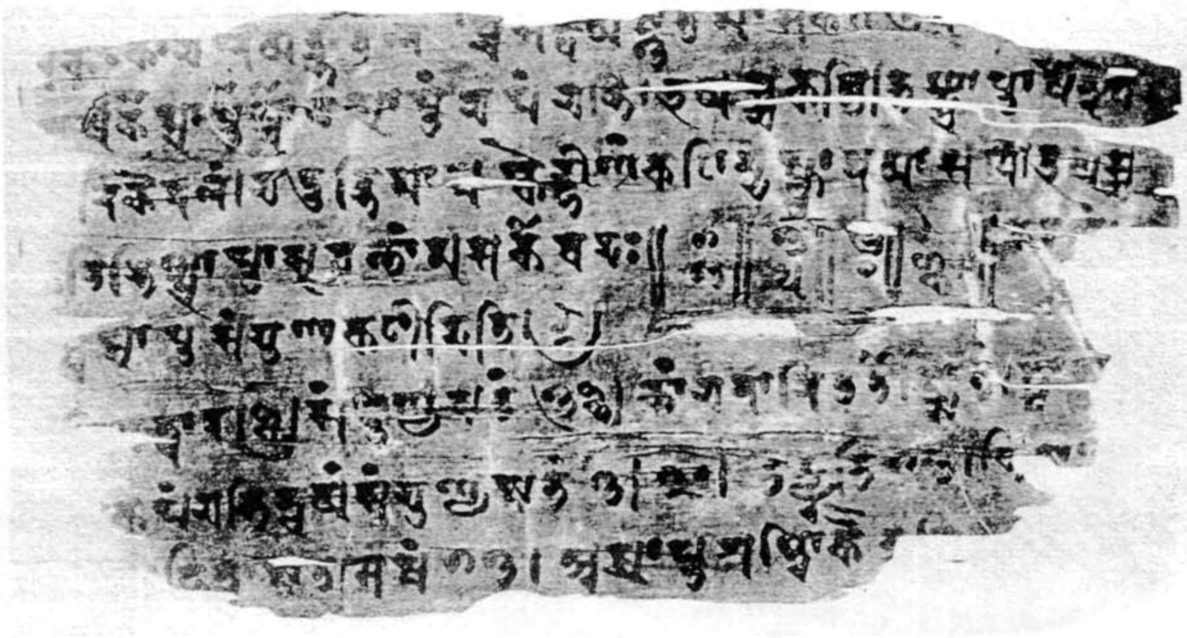
III 33 17[R]





III 34 17[V]

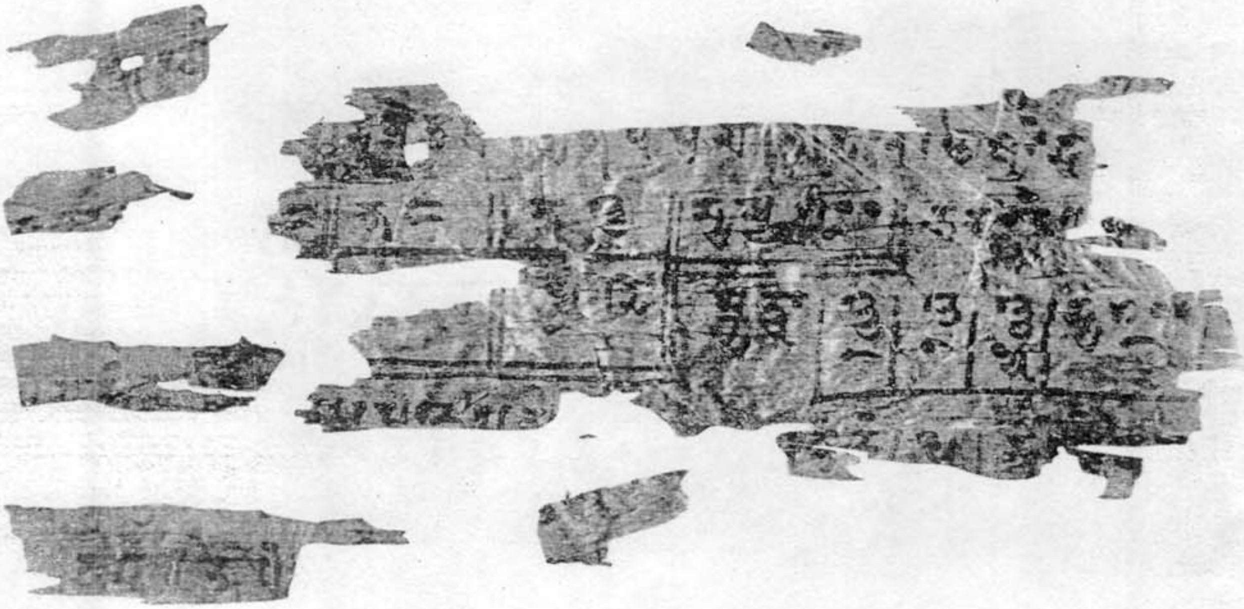
III 35 18R





III 36 18V

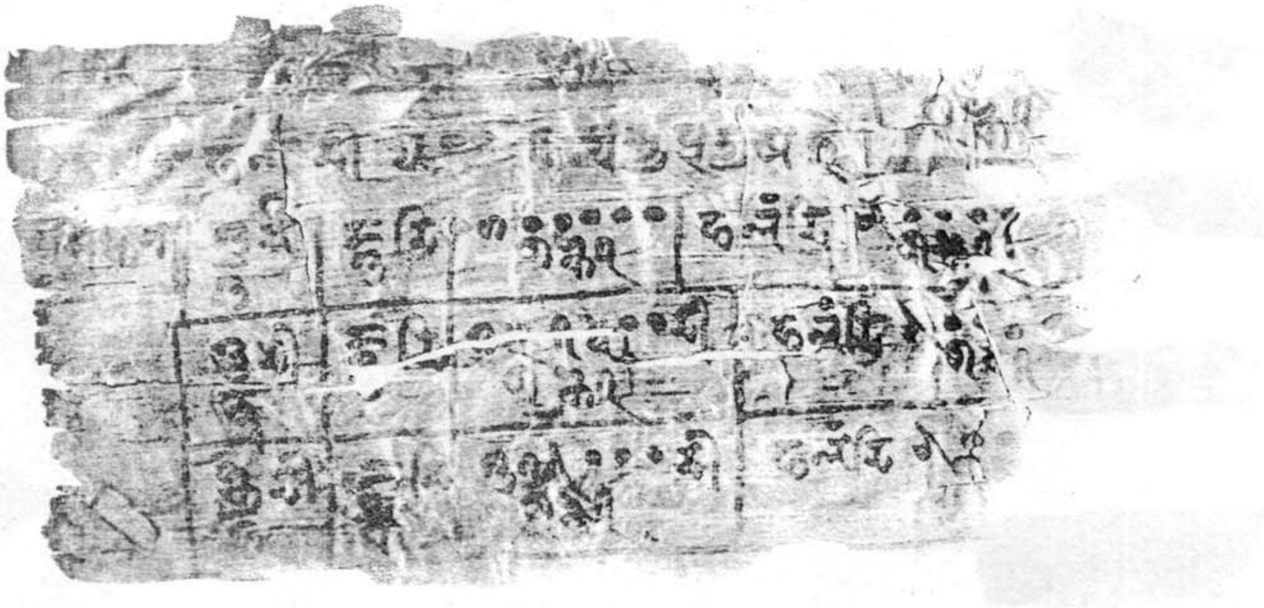
IV 1 21^{R}

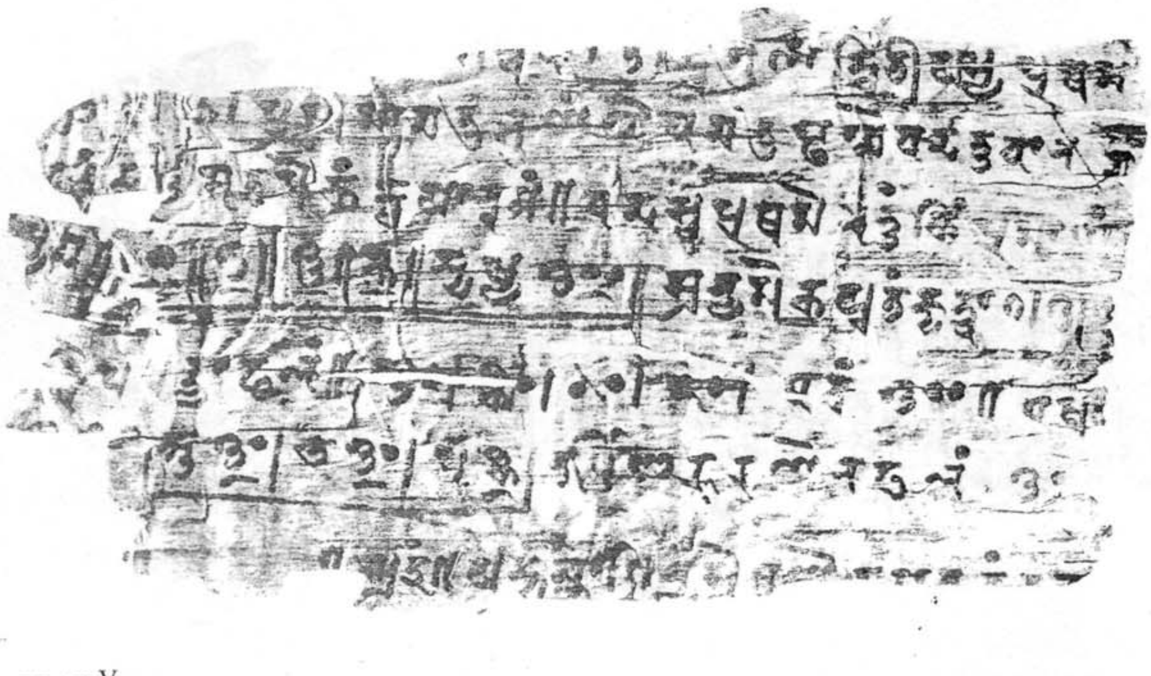




IV 2 21^{V}

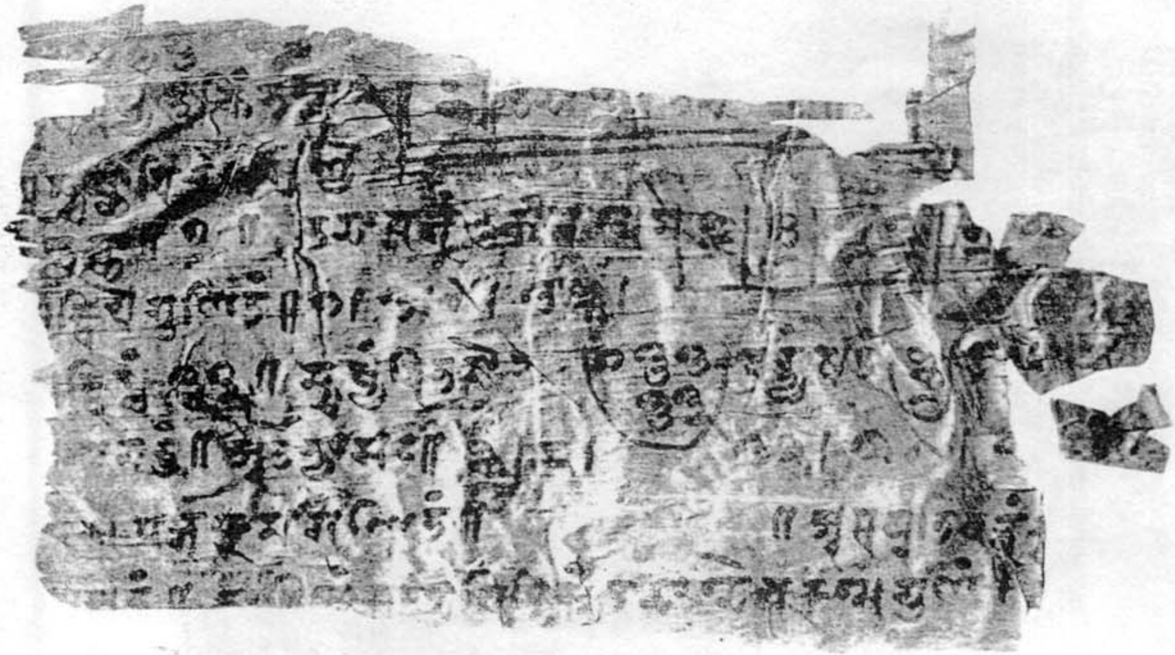
IV 3 22R





IV 4 22V

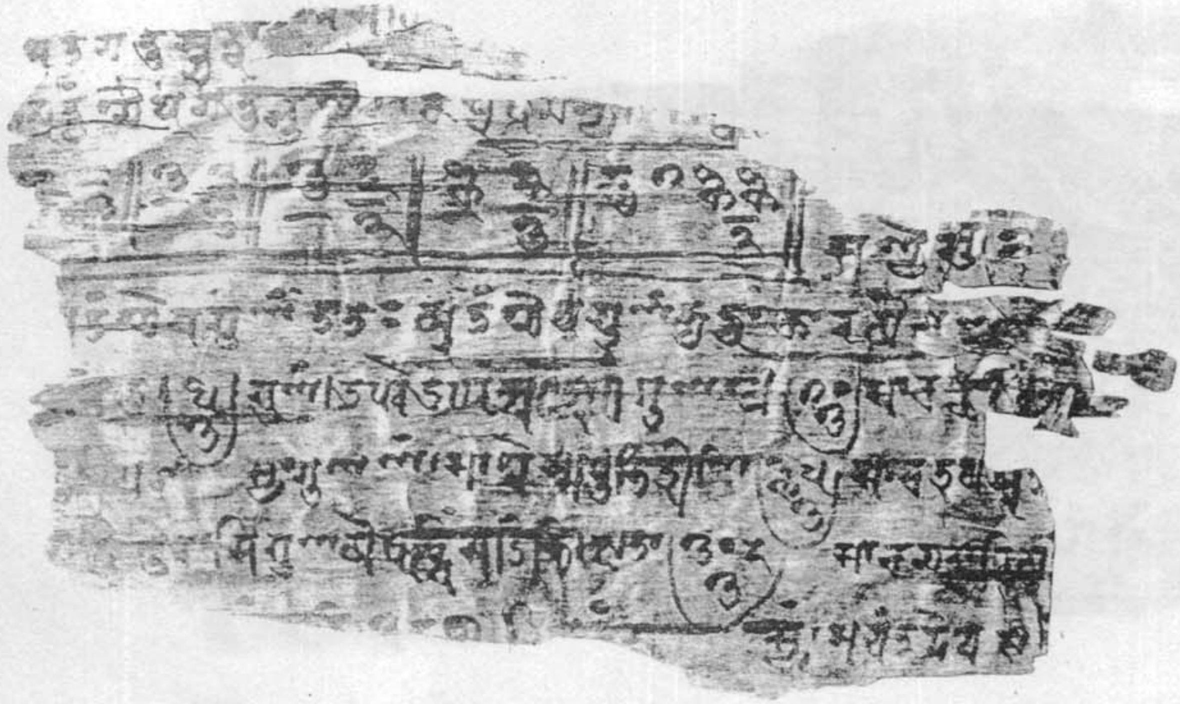
IV 5 23R





IV 6 23V

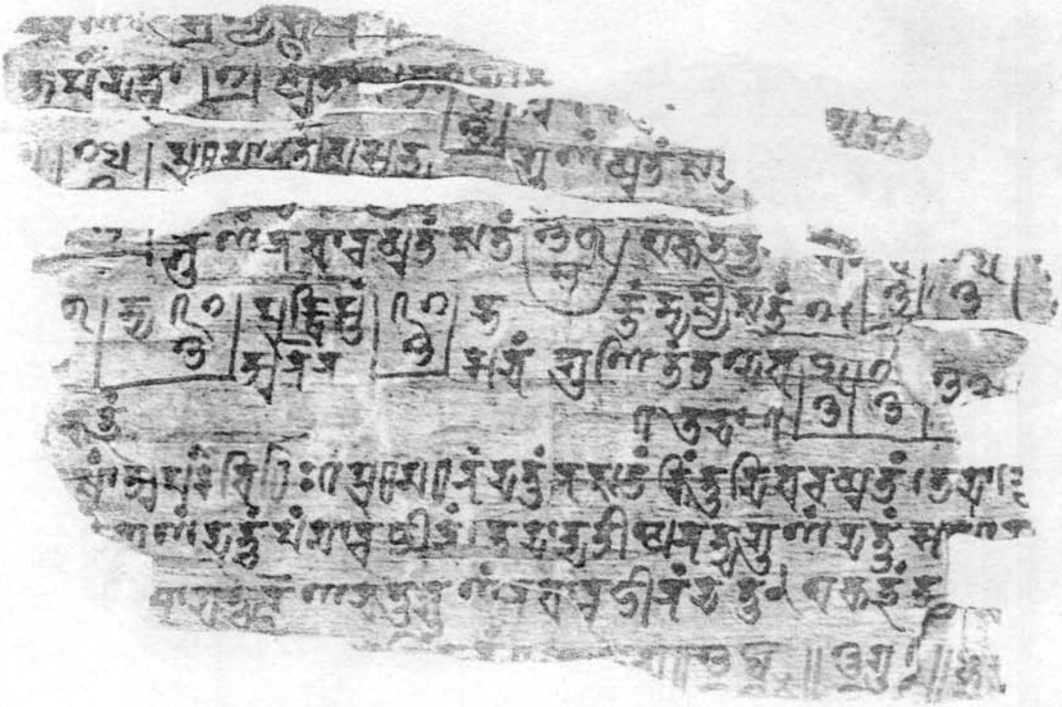
IV 7 24R





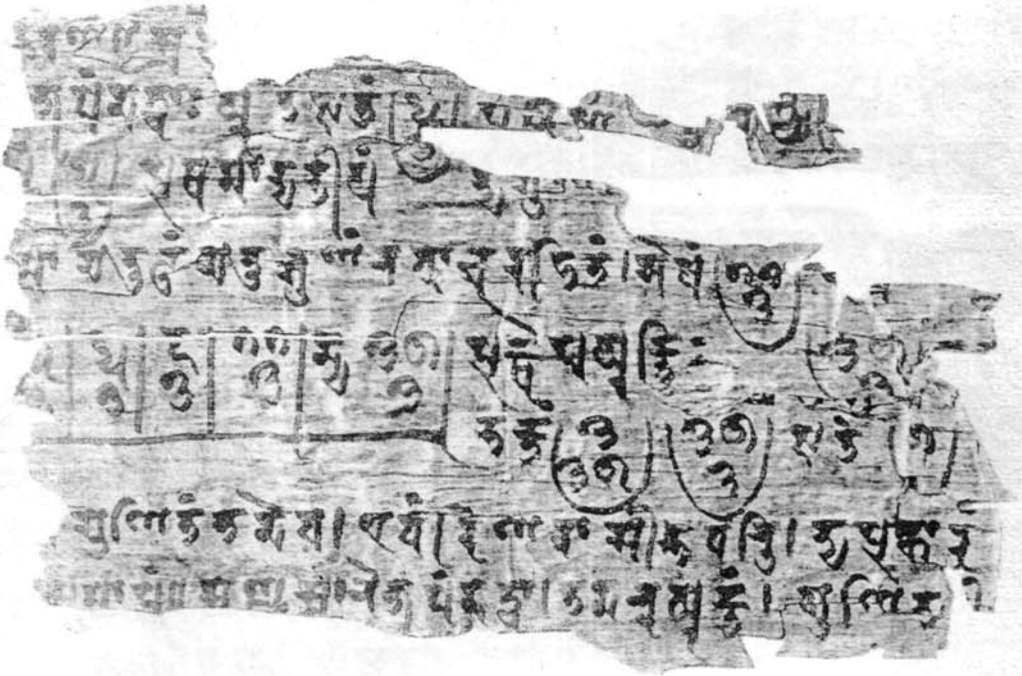
IV 8 24V

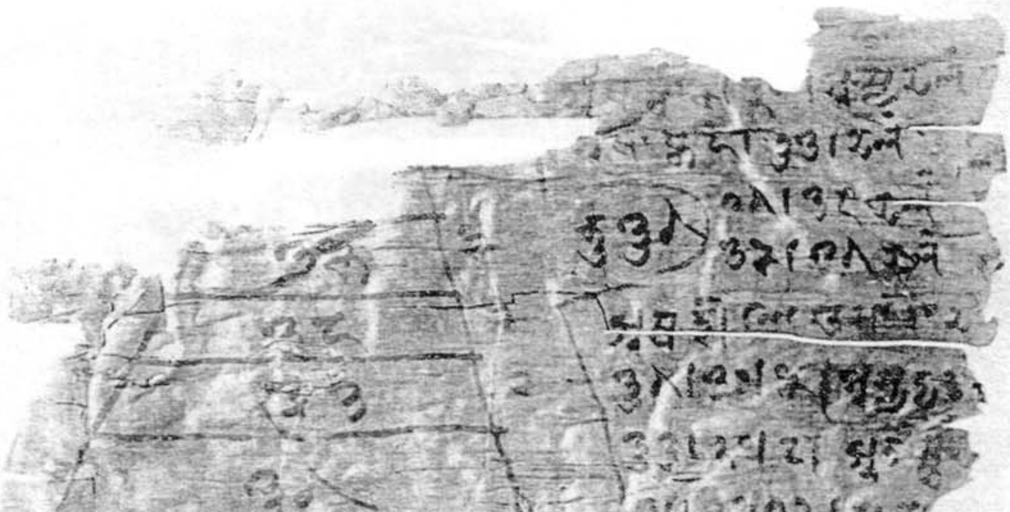
IV 9 25^{V}





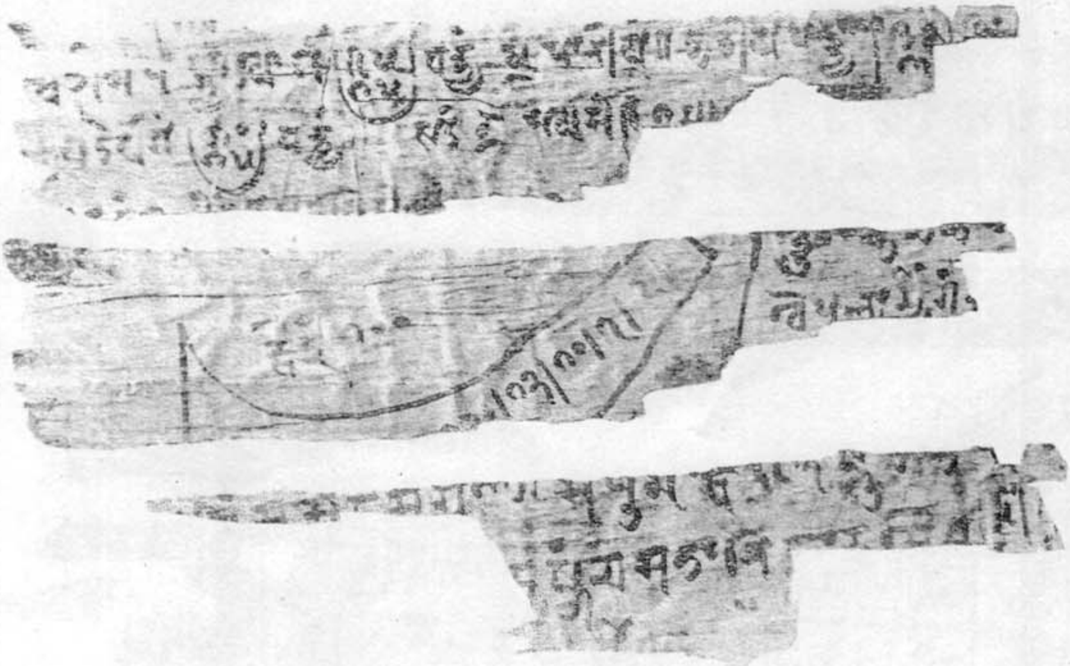
IV 10 25^{R}





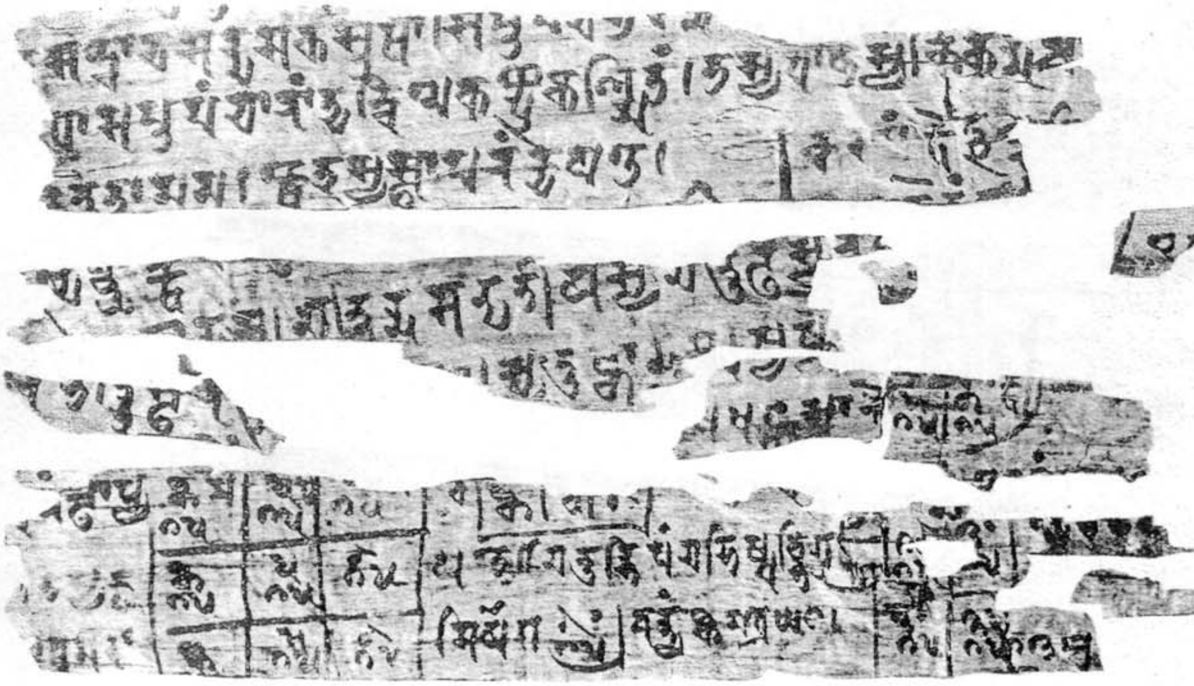
IV 12 26V

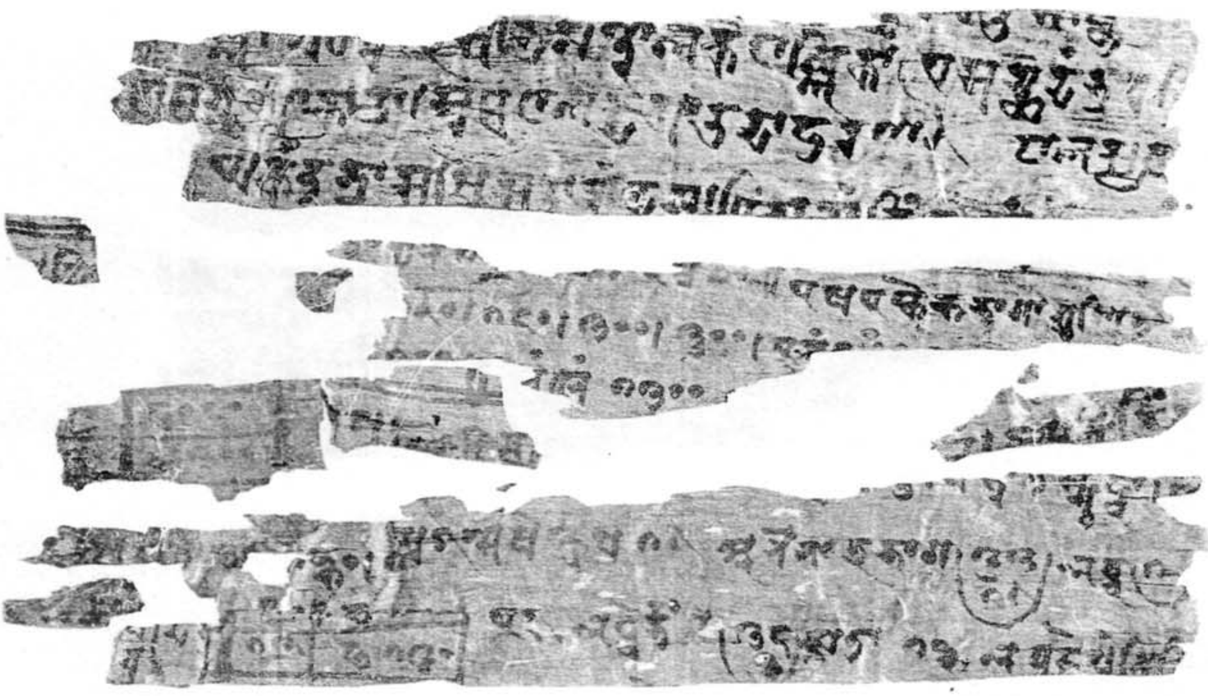
V 2,3,5 38^{R}





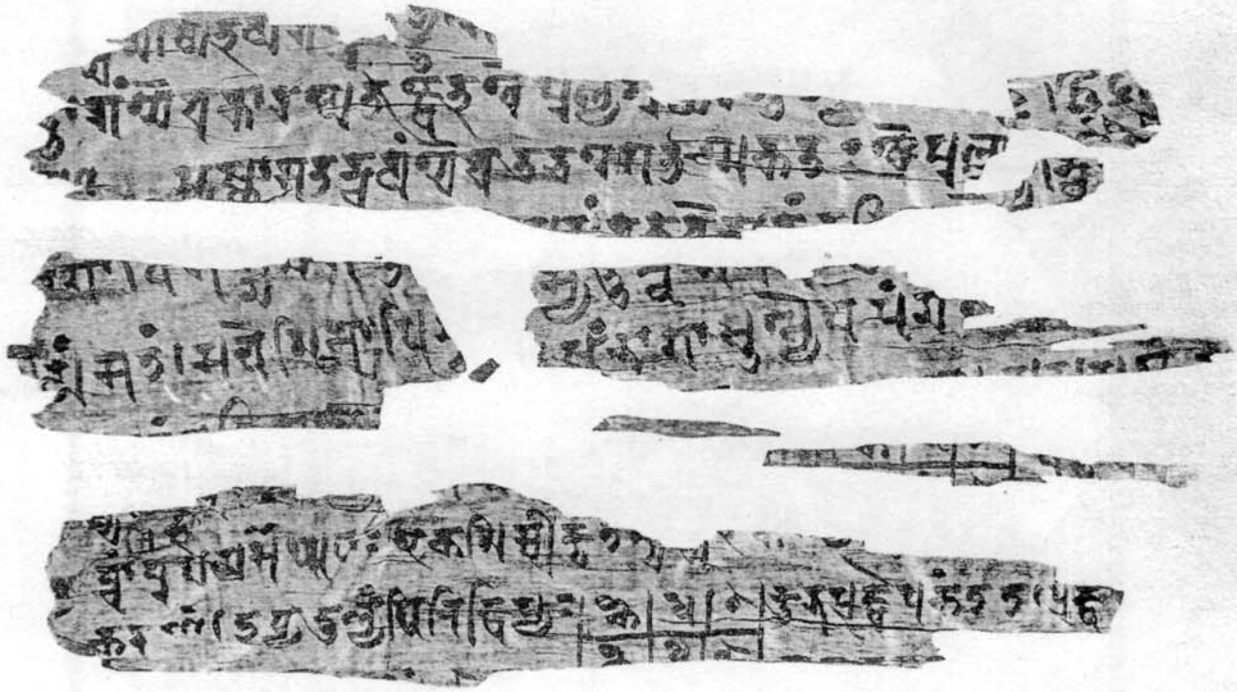
V 1,4,6 38^{V}





V 1,4,6 39V

V 2,3,5 40R

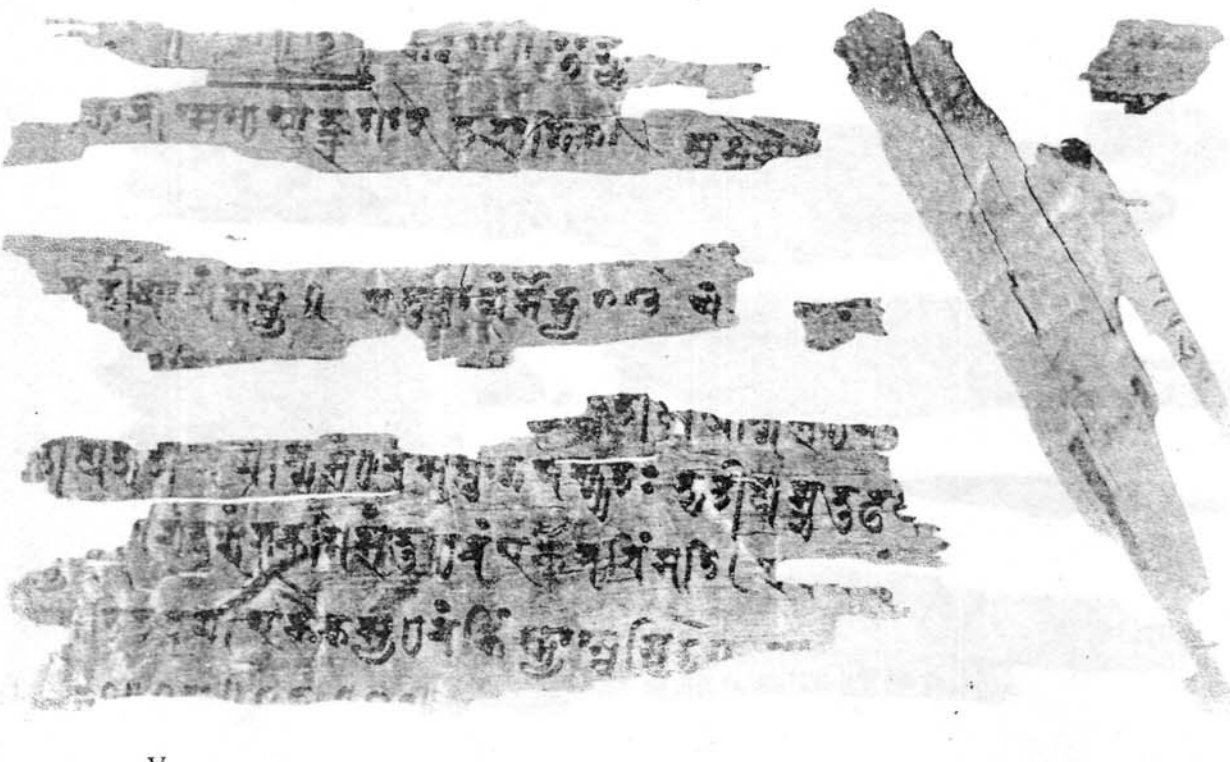




V 1,4,6 40V

VI 1,4 29R





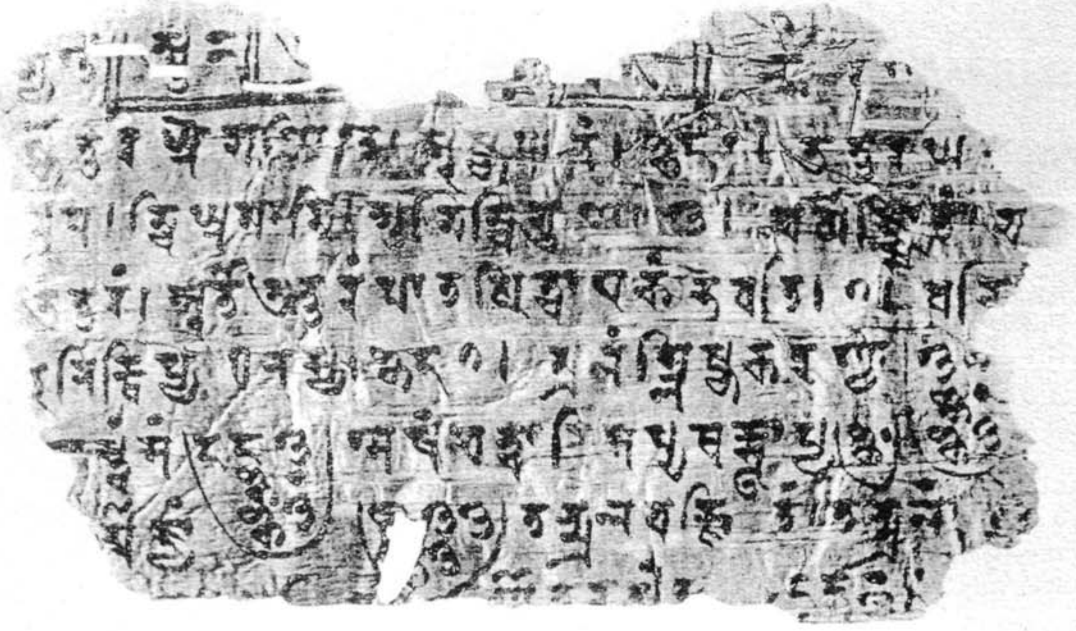
VI 2,3 29V

VI 3 27V



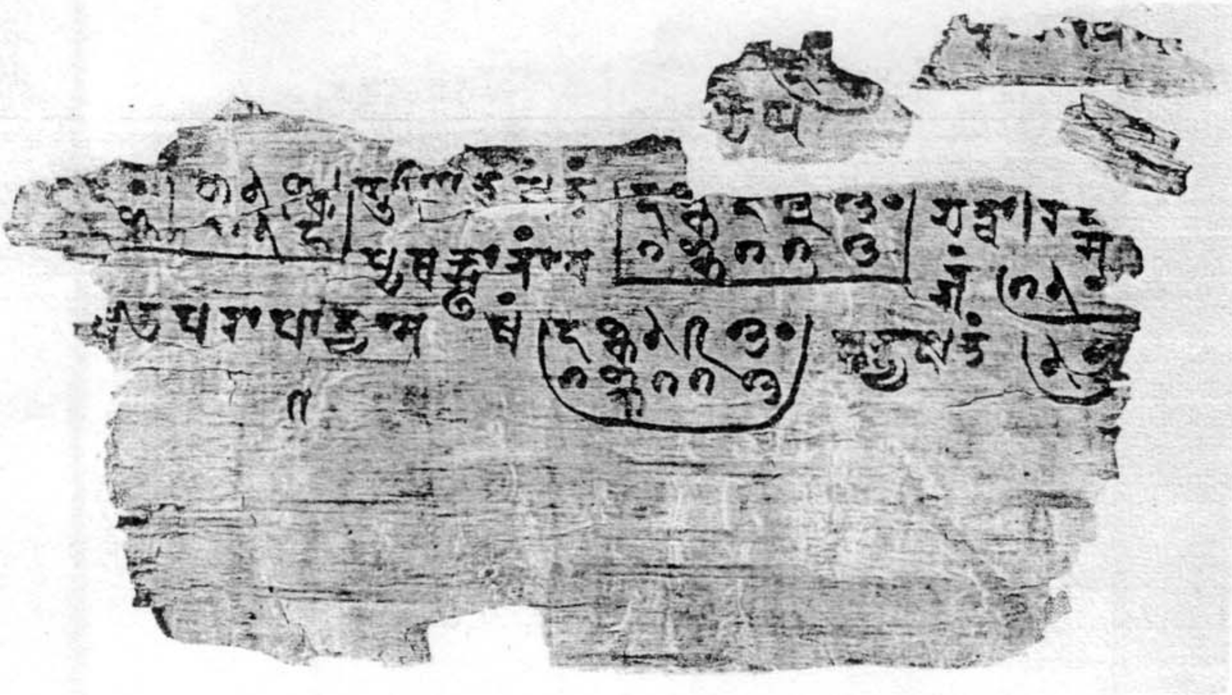


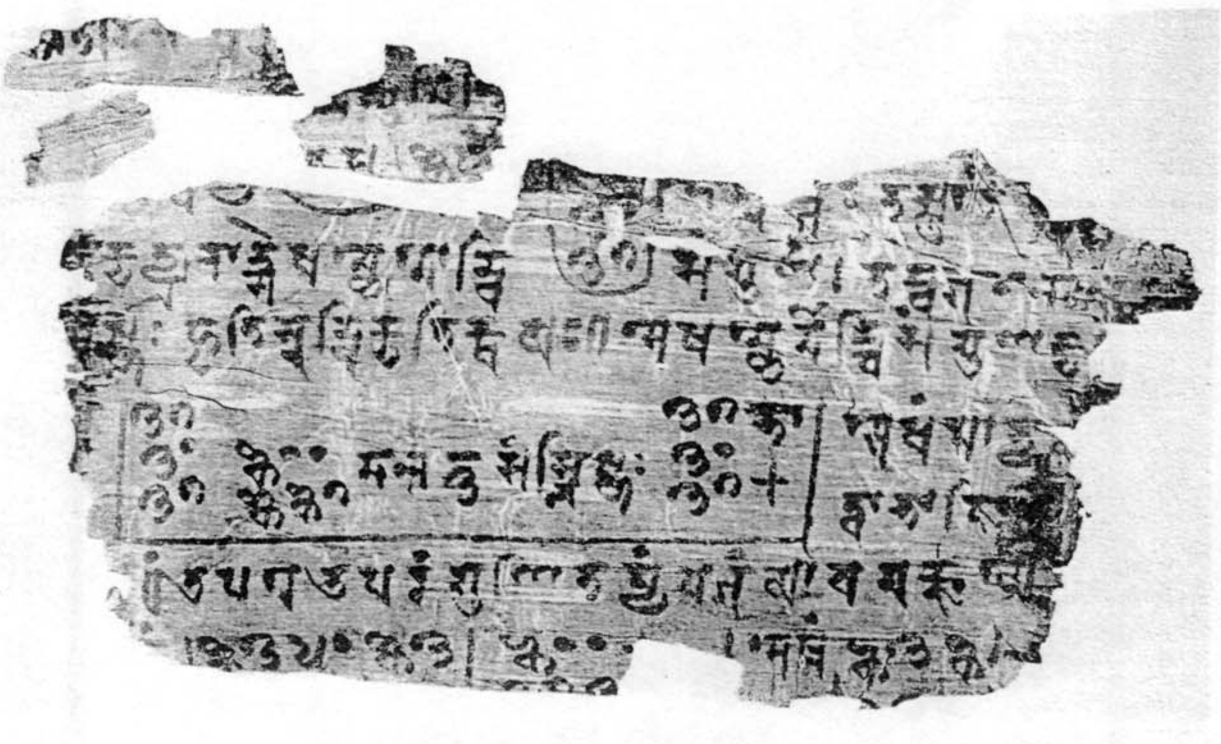
VI 4 27R



(niets)

VII 2 56V





VII 3 56R

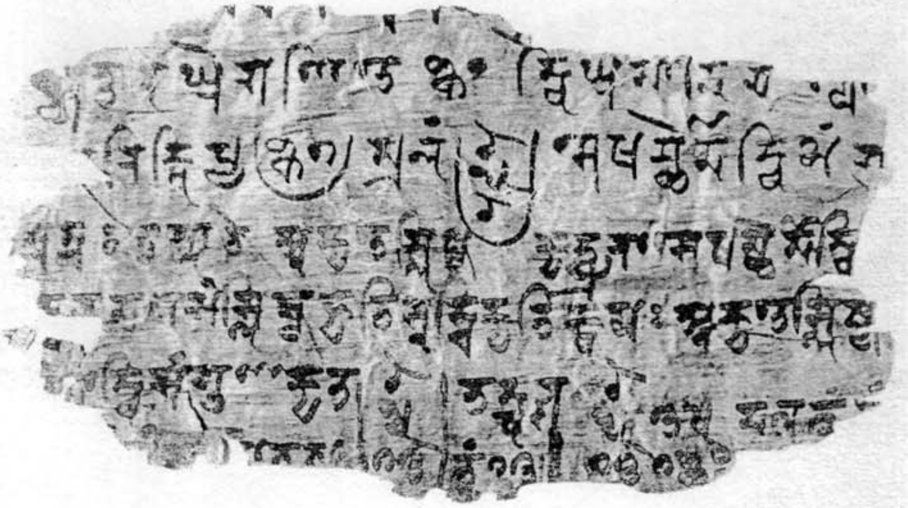
VII 4 64R





VII 5 64V

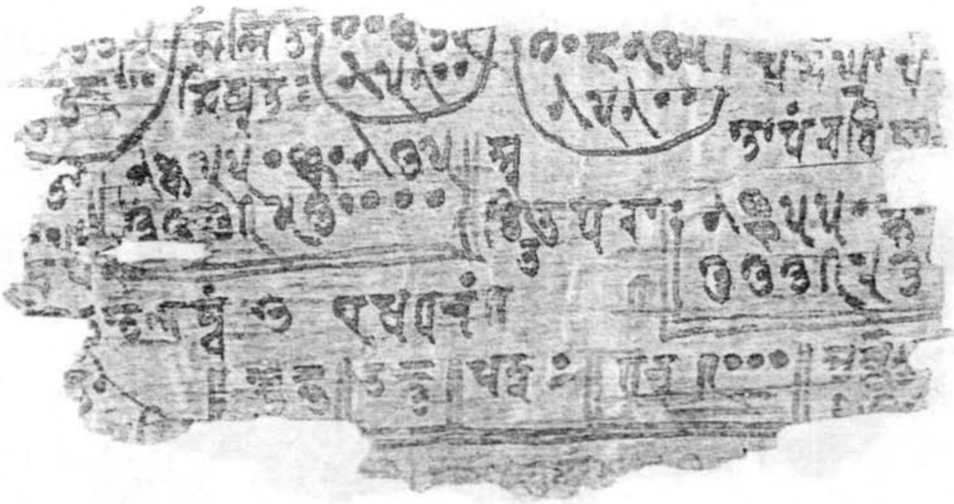
VII 6 57V

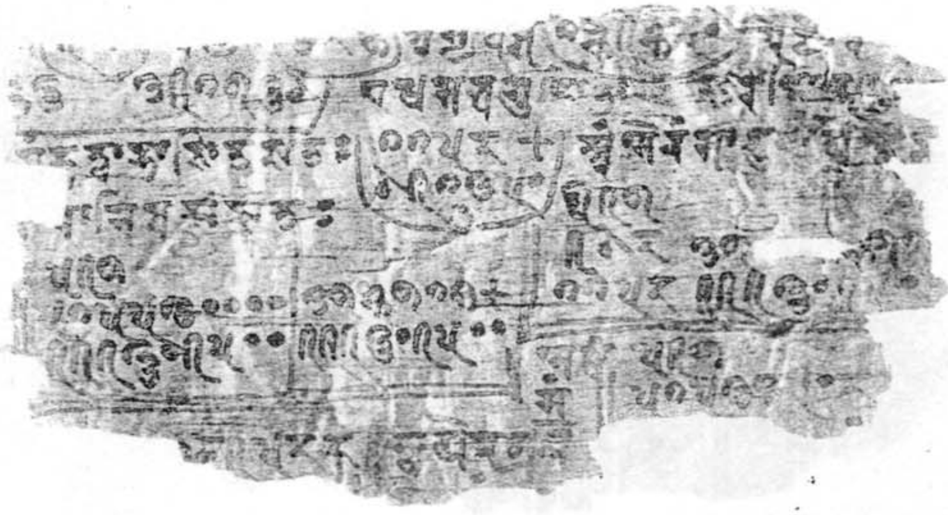




VII 7 57R

VII 8 45R

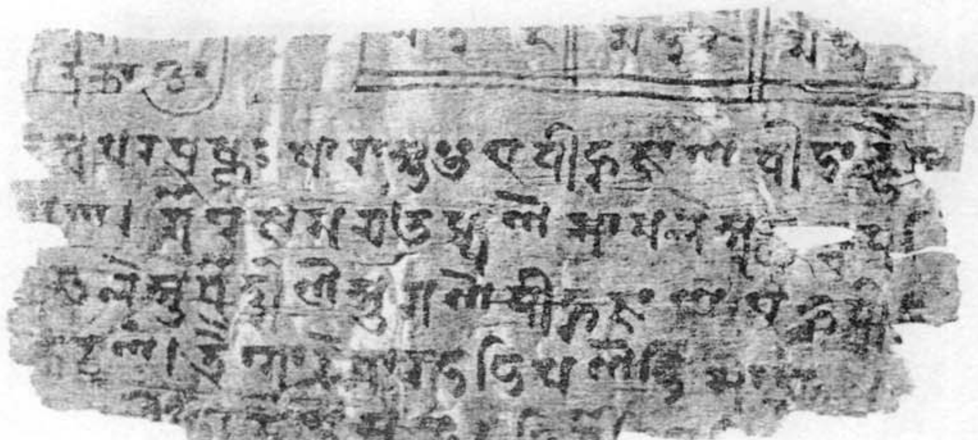




VII 9 45V

VII 10 46R

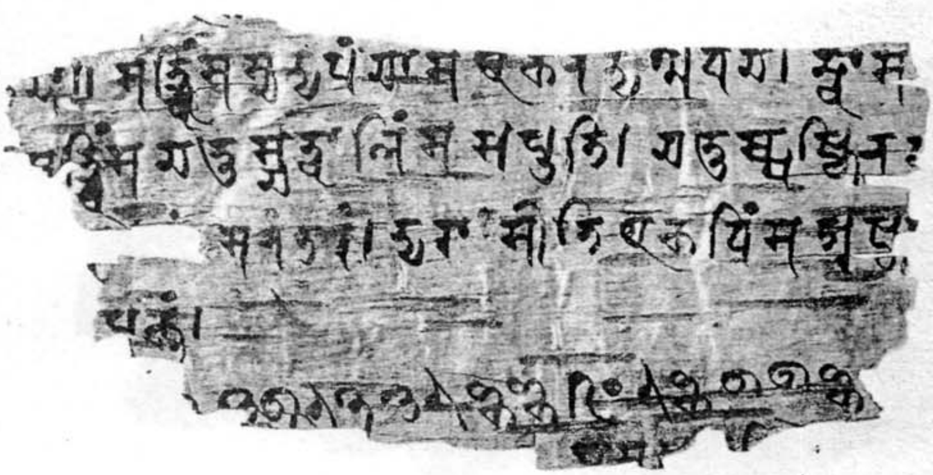




VII 11 46V

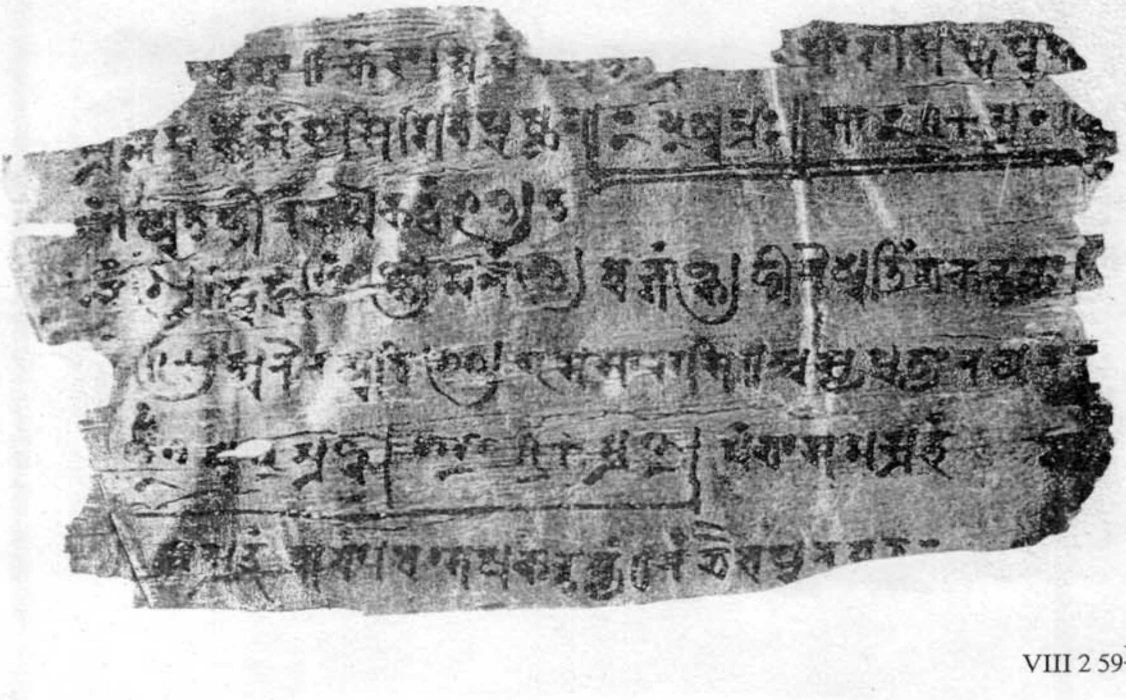
VII 12 58V





VII 13 58R

VIII 1 59V



VIII 2 59R

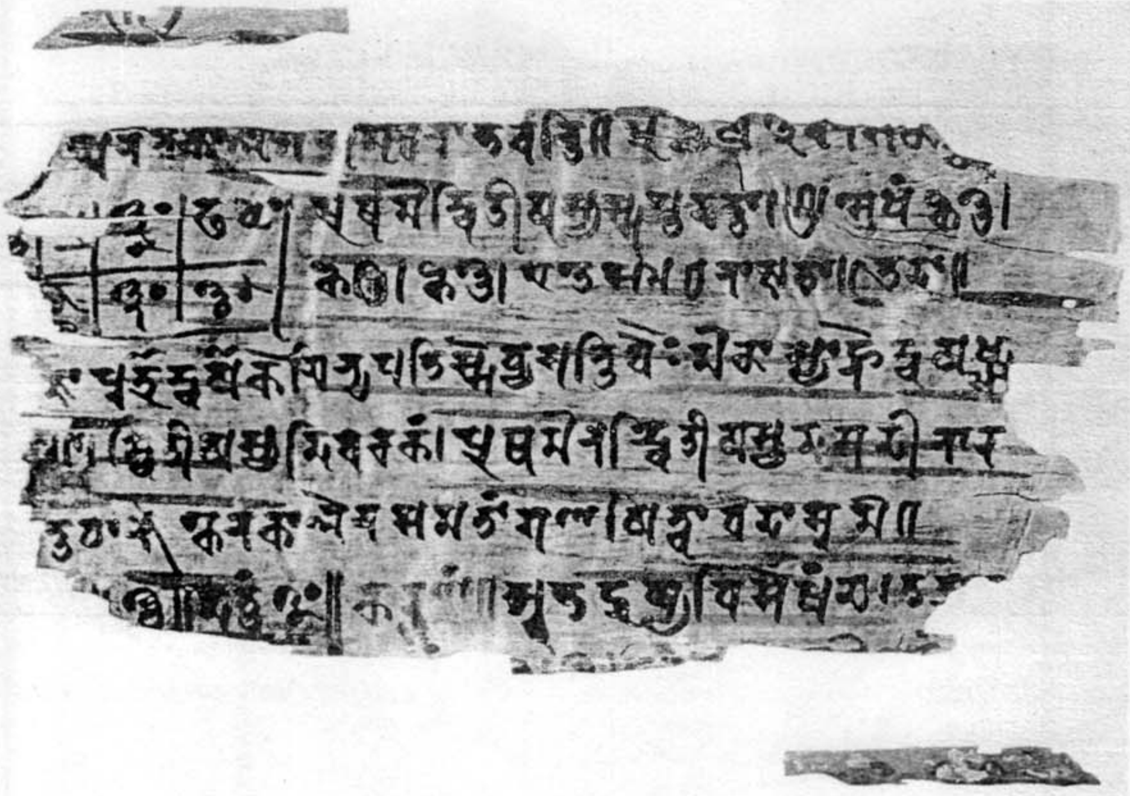
VIII 3 60^{R}





VIII 4 60^{V}

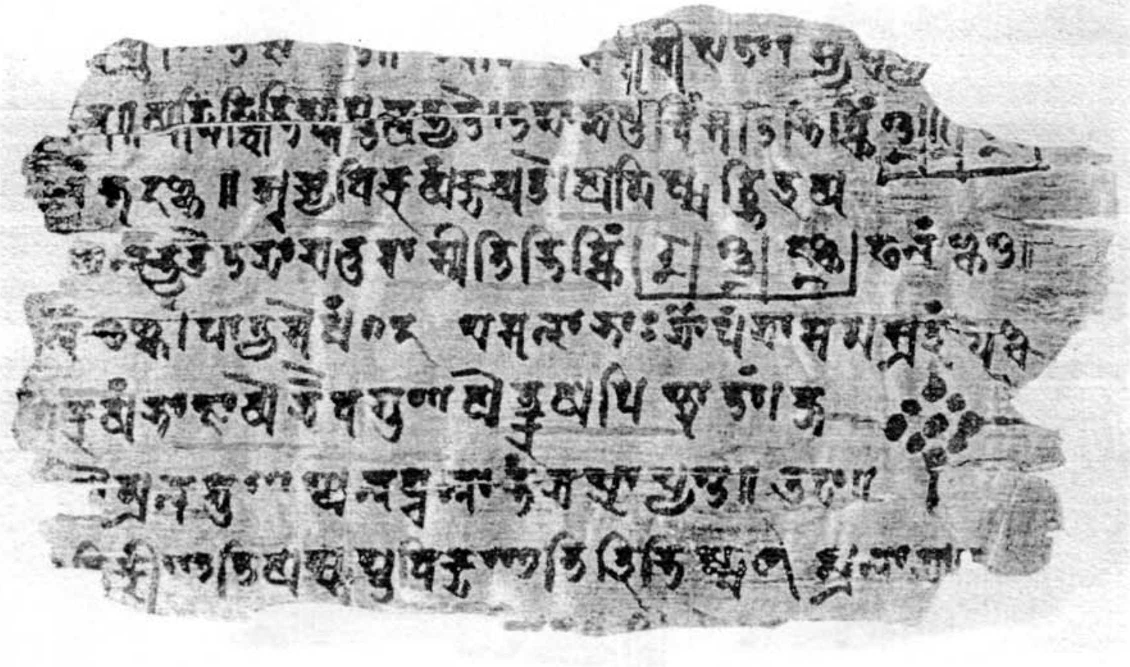
VIII 5 61R

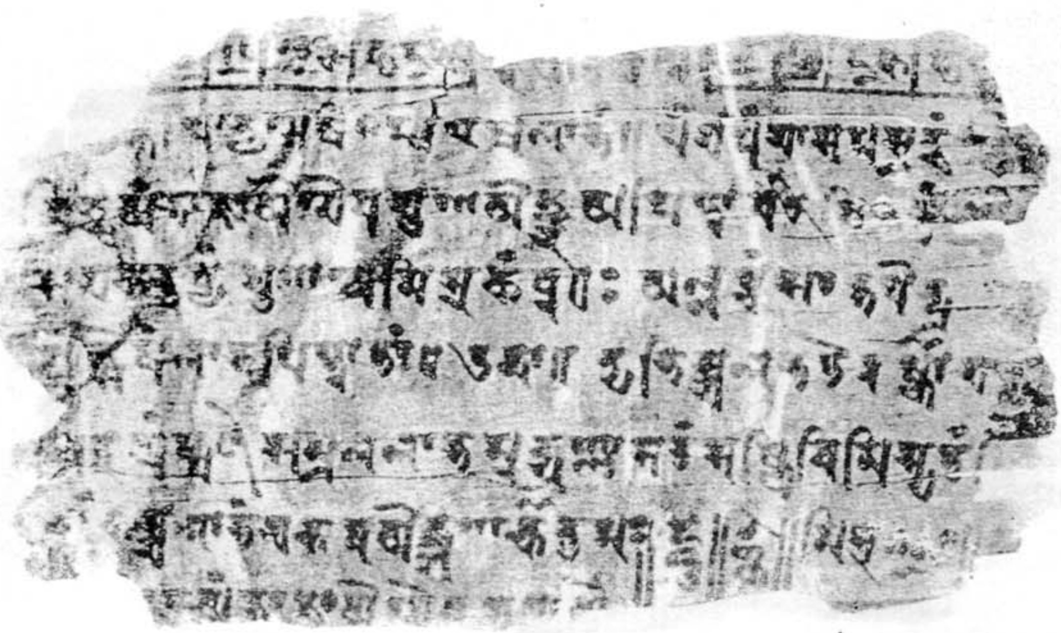




VIII 6 61V

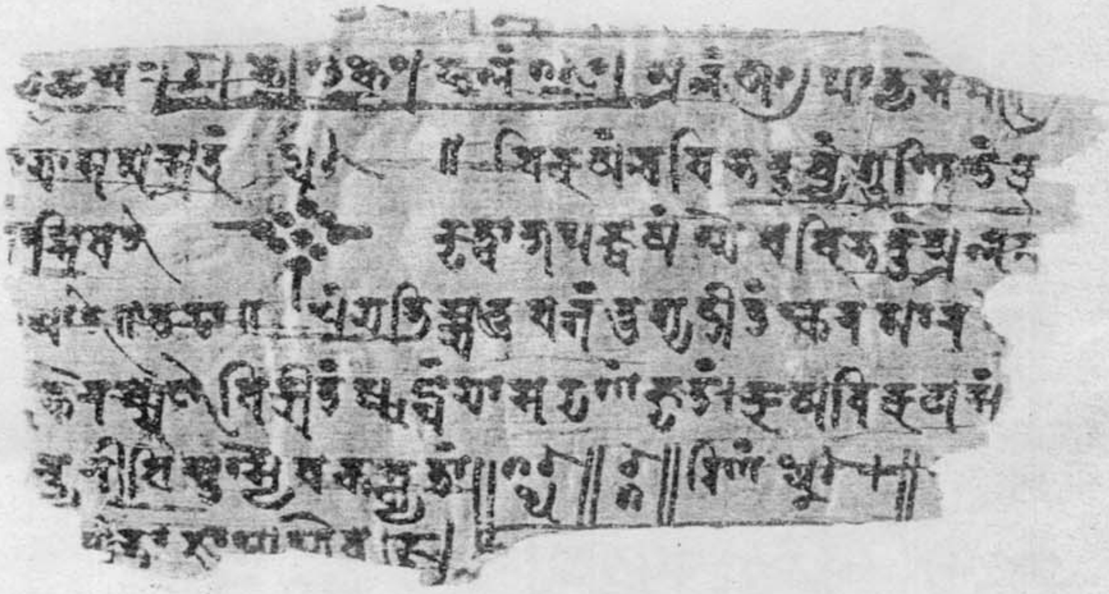
VIII 7 62R





VIII 8 62V

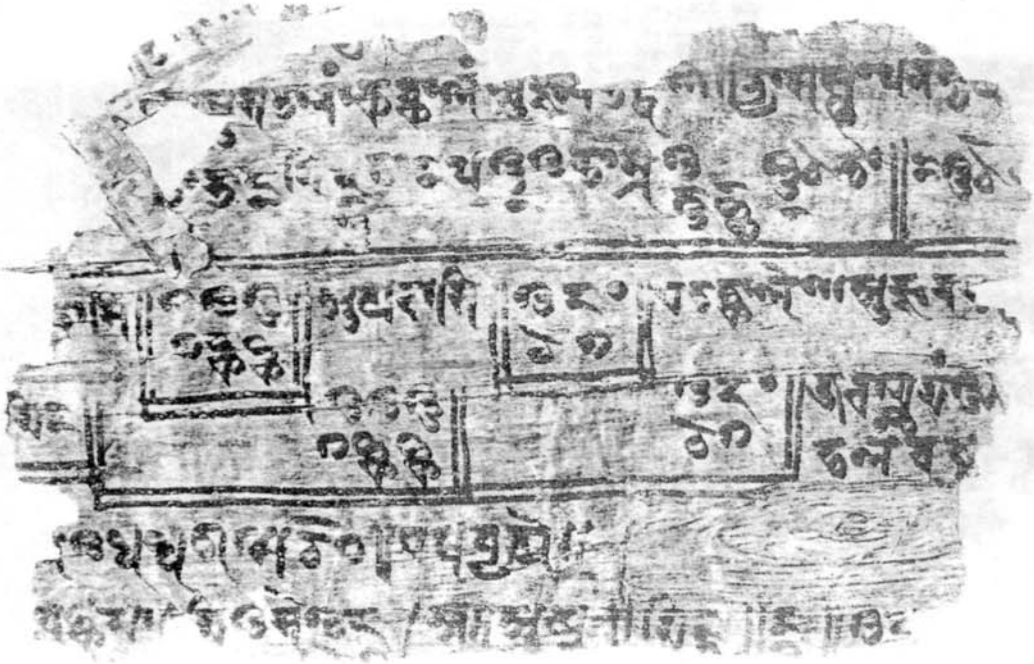
VIII 9 63R

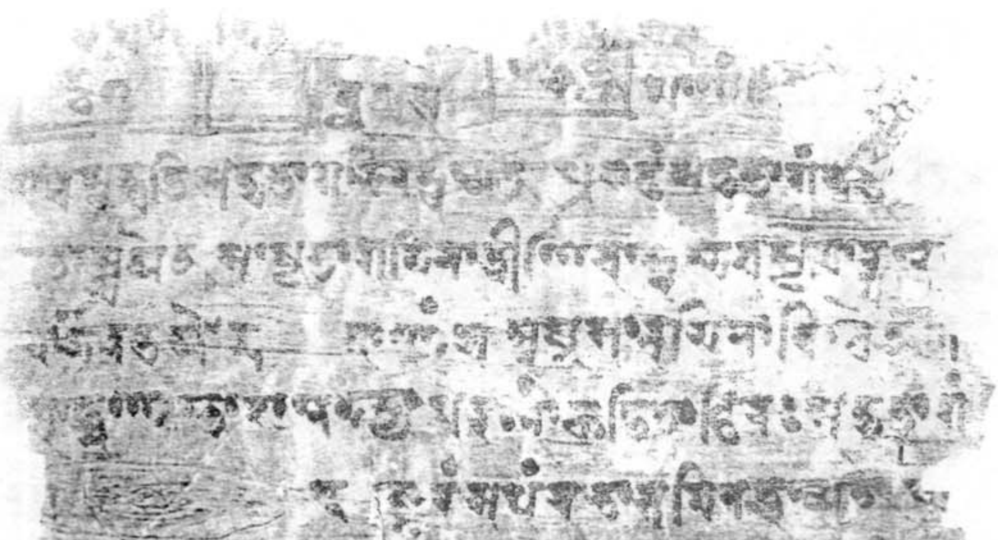




VIII 10 63V

IX 1 44V





IX 2 44R

IX 3 43R





IX 4 43V

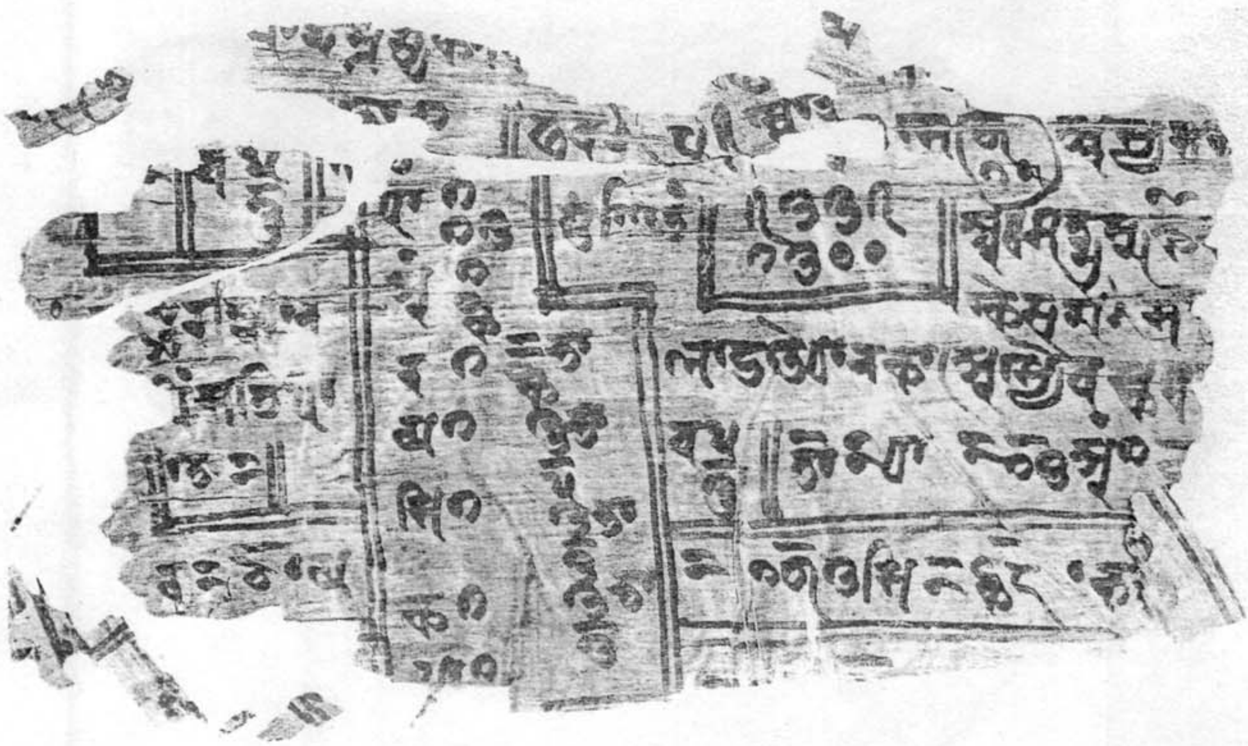
X 1 49V





X 2 49R

X 3 55R





X 4 55V

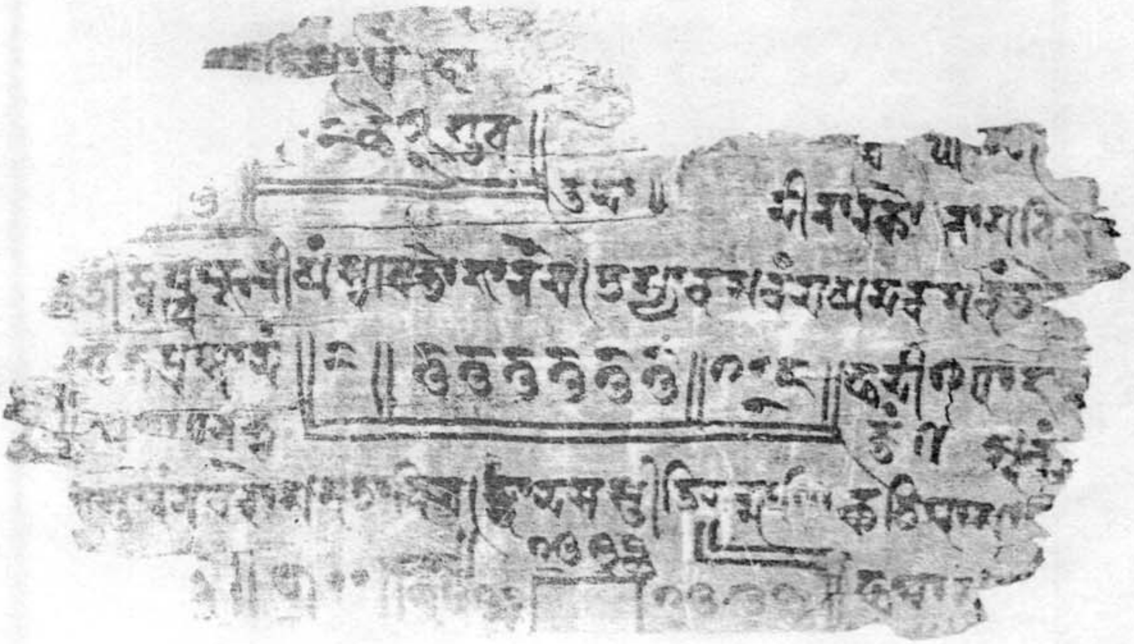
X 5 20R

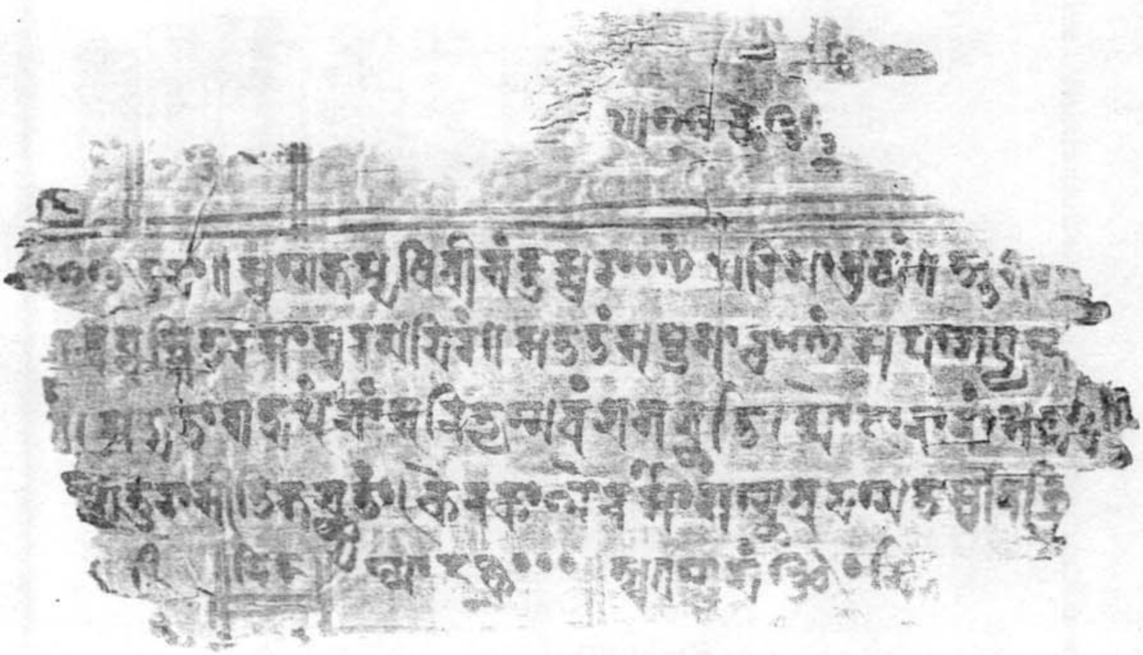




X 6 20V

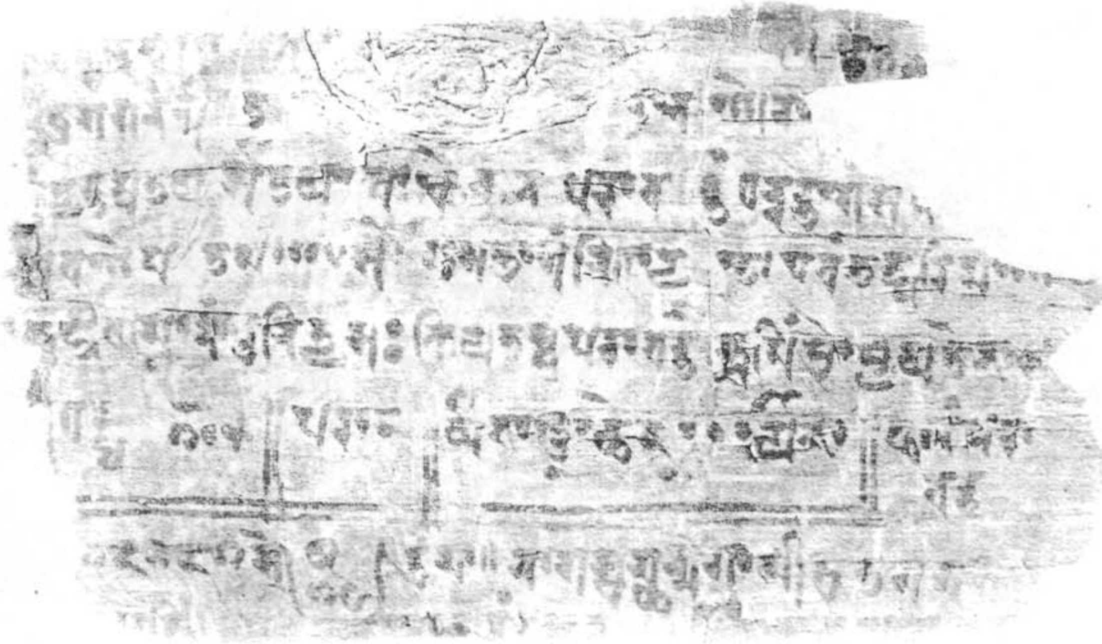
X 7 33R

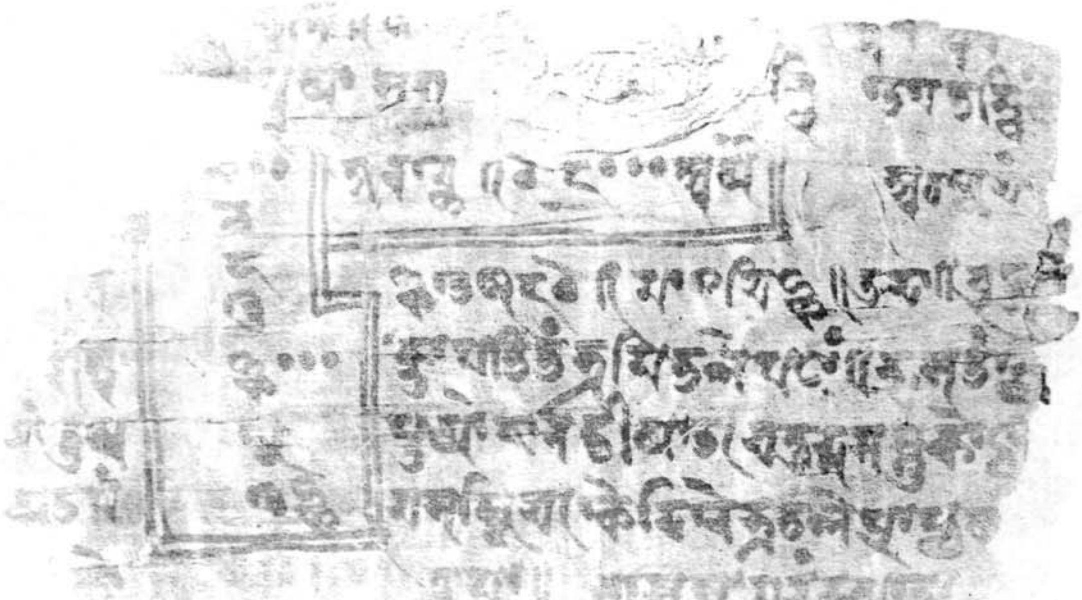




X 8 33V

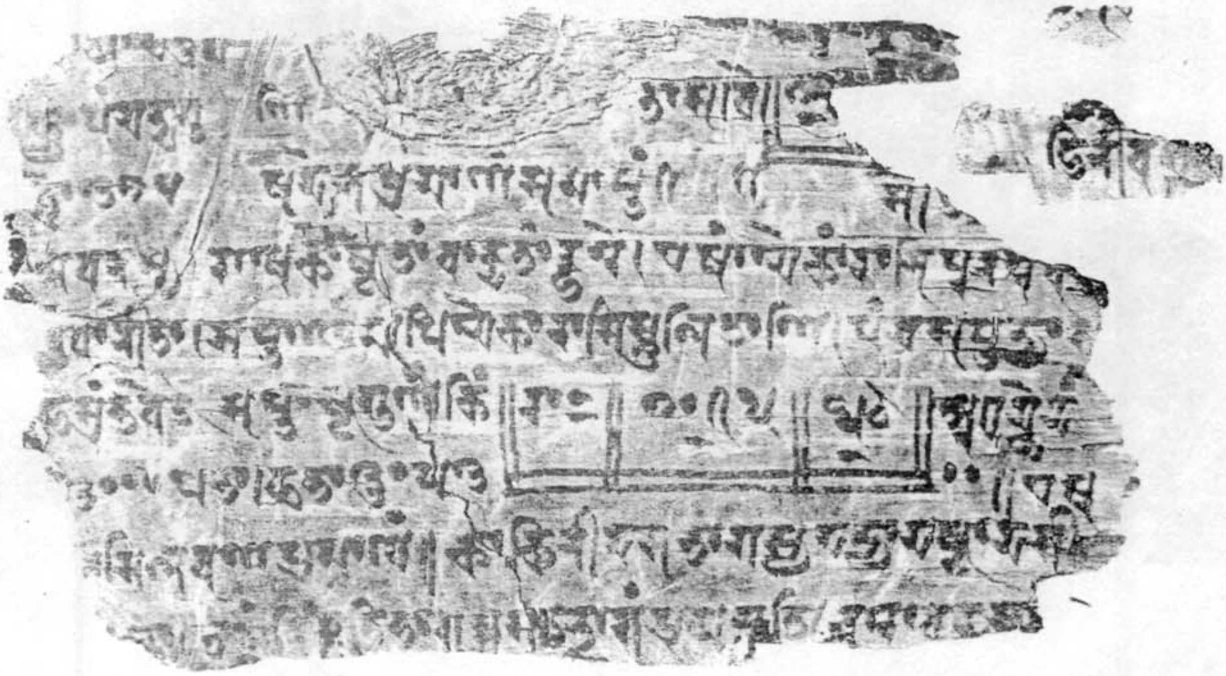
X 9 32R





X 10 32V

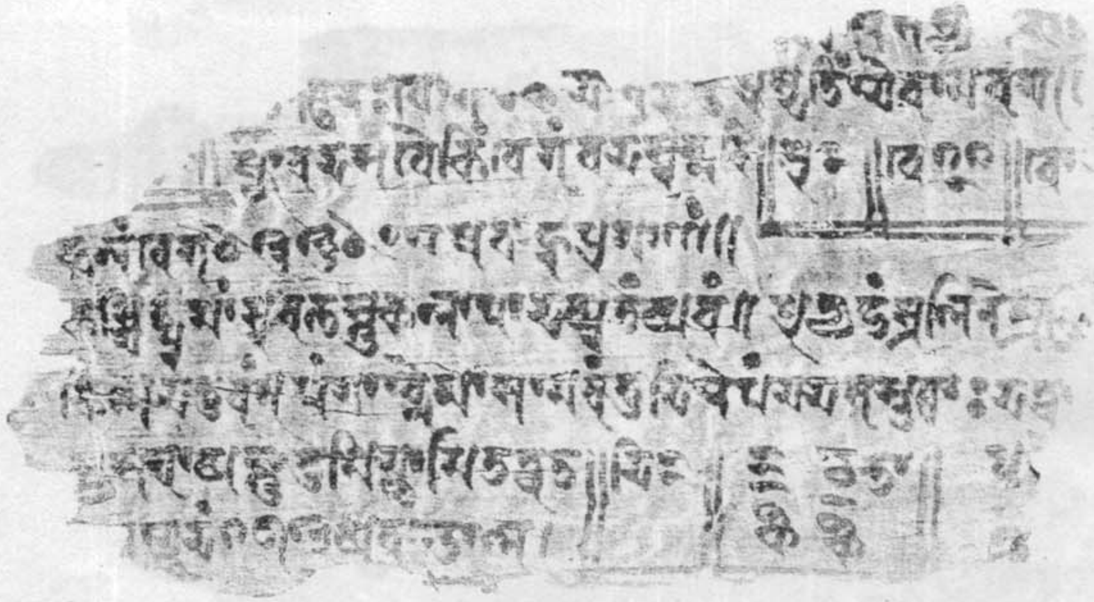
X 11 36R

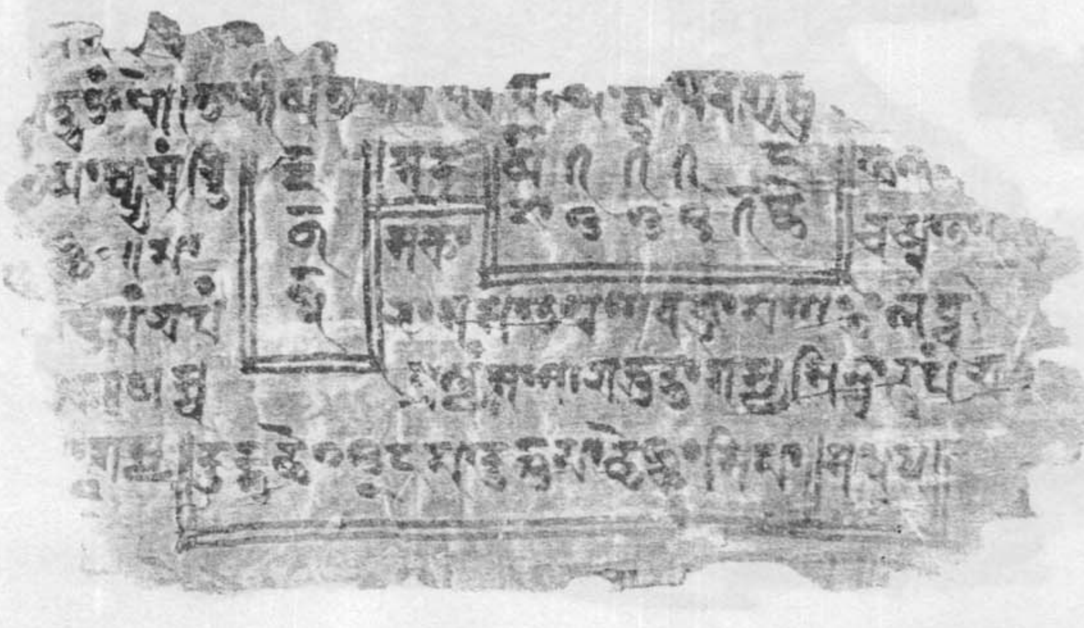




X 12 36V

X 13 34R





X 14 34V

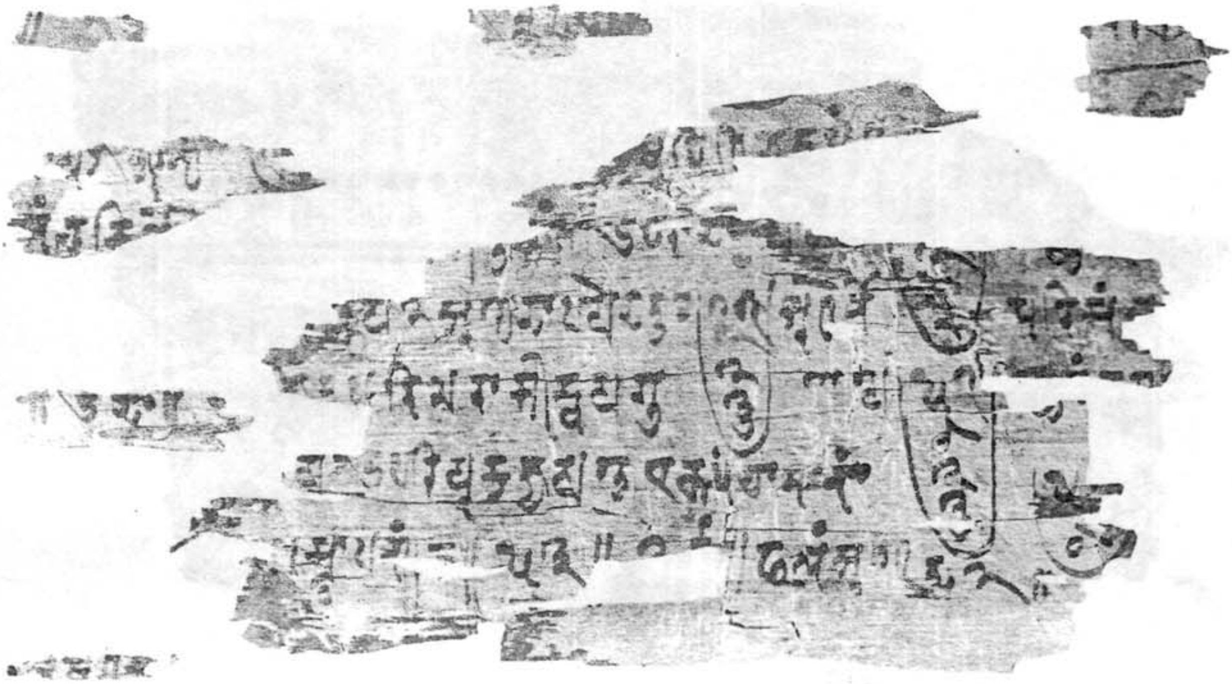
X 15 37R





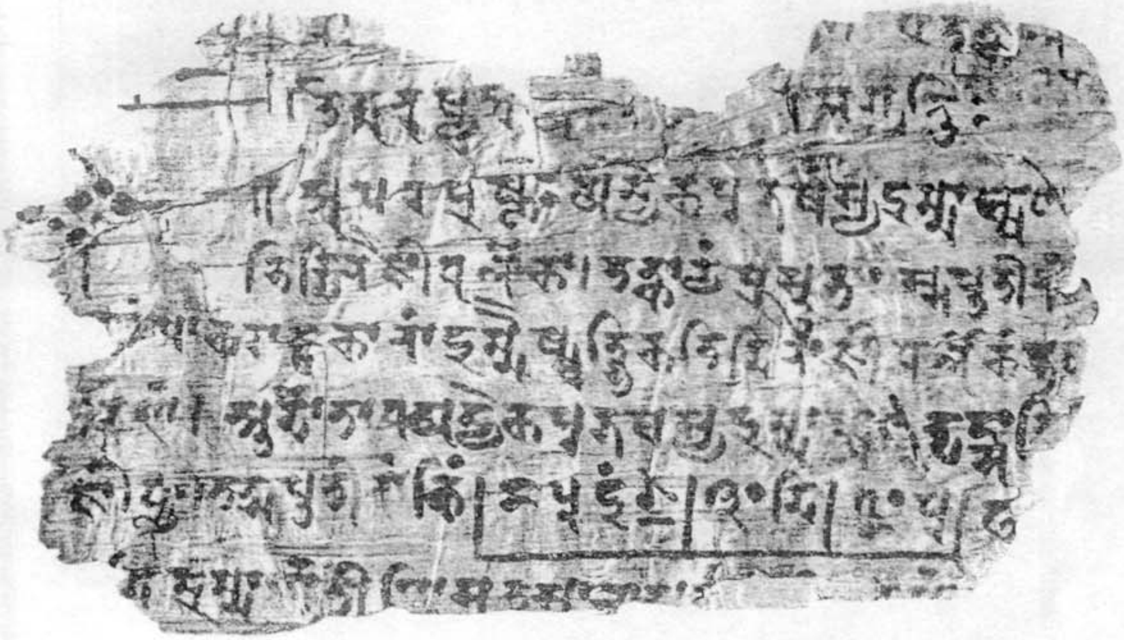
X 16 37V

X 17 41V



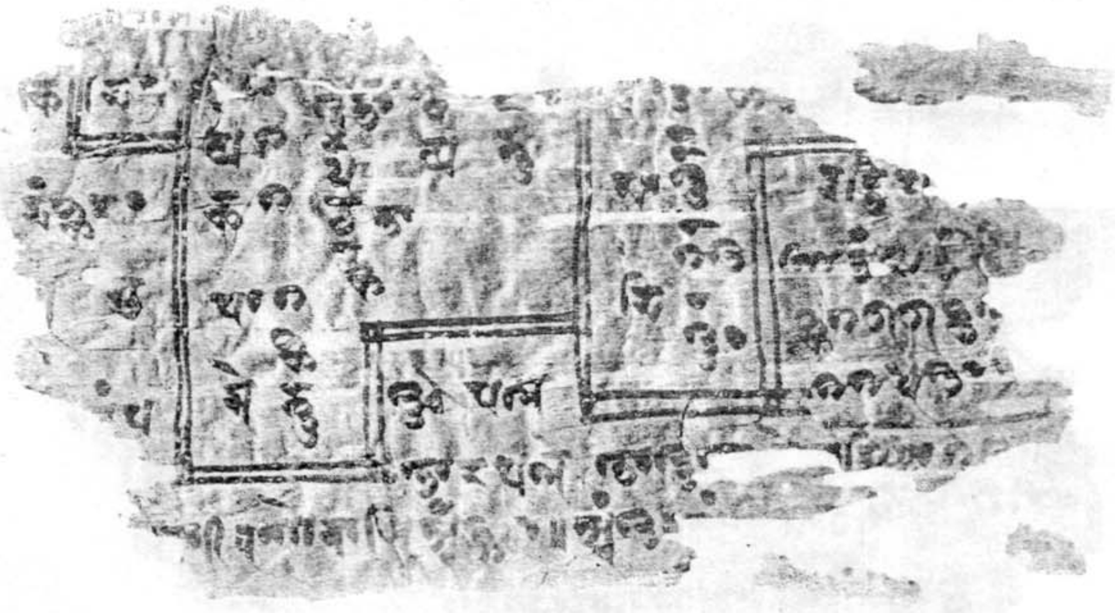


X 18 41R



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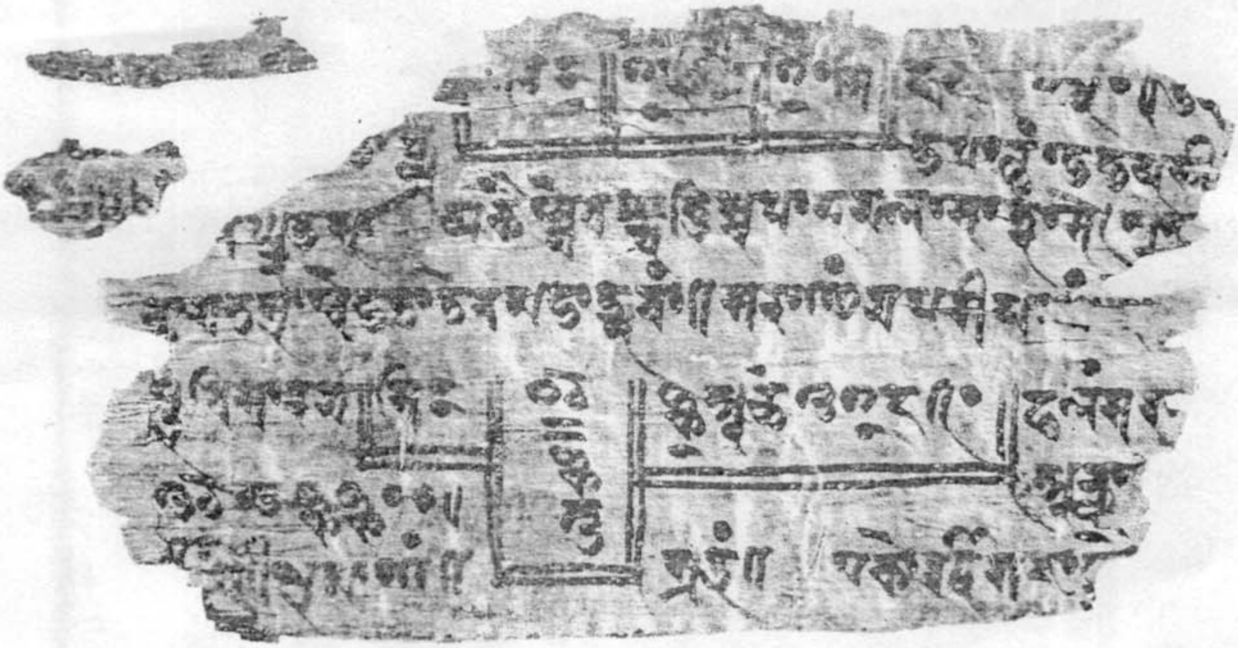
X 20 48R





X 21 48V

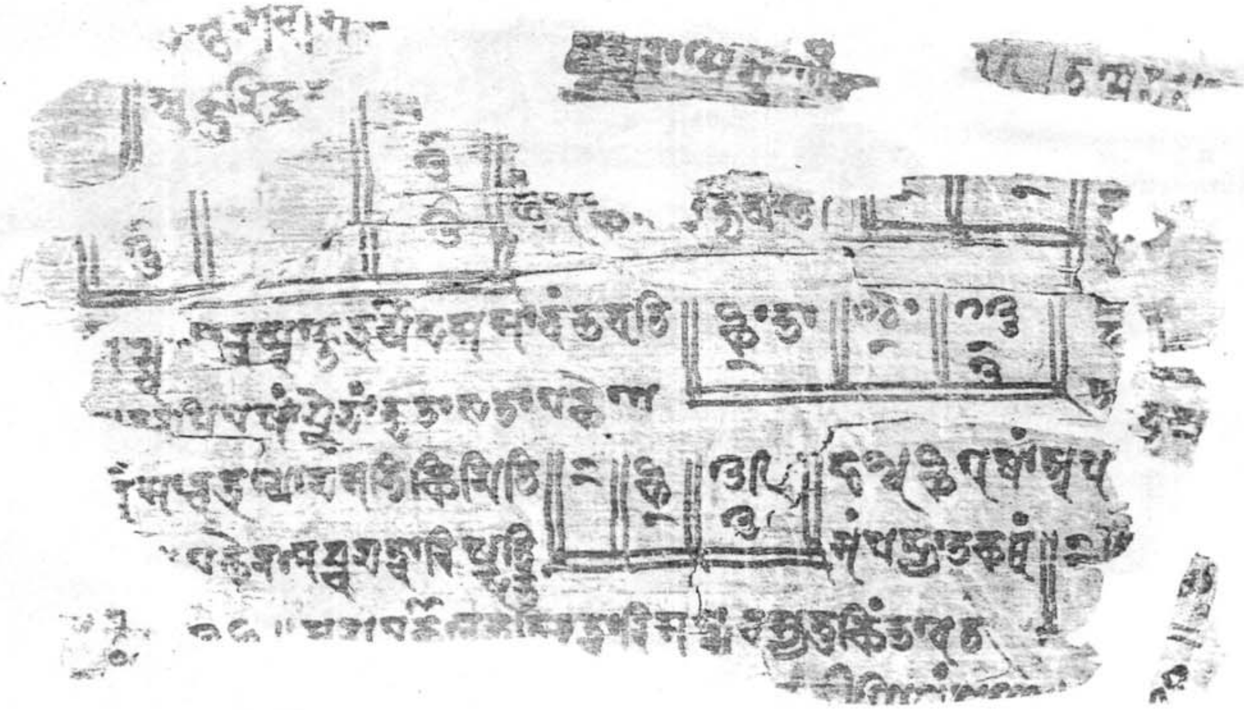
X 22 47V





X 23 47R

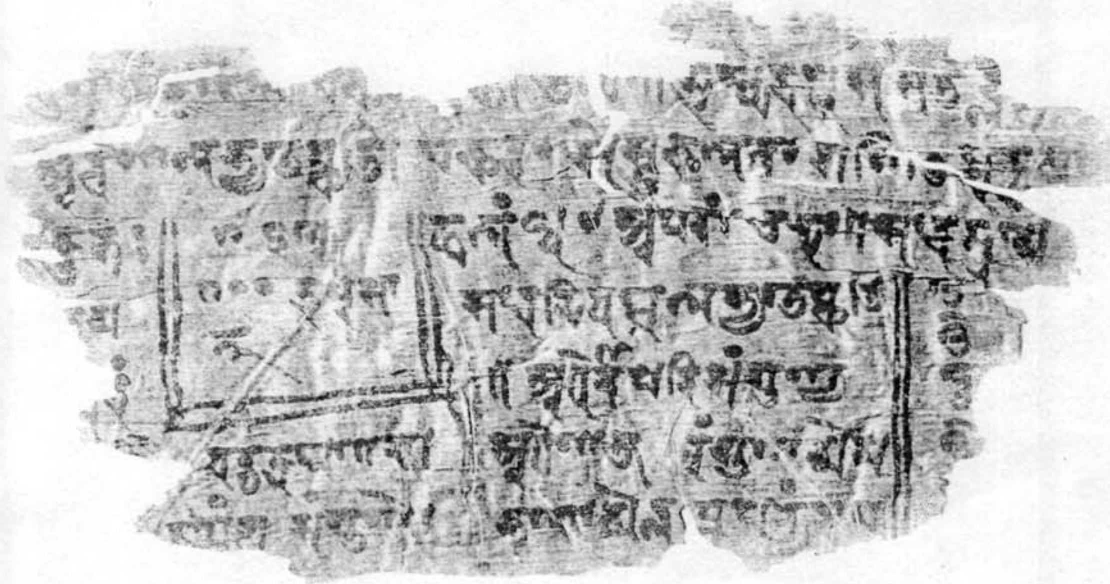
X 24 42R





X 25 42V

X 26 50V





X 27 50R